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DEPARTMENT OF MINES AND RESOURCES
HON. T. A. CRERAR, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

MINES AND GEOLOGY BRANCH
JOHN MCLEISH, DIRECTOR

BUREAU OF GEOLOGY AND TOPOGRAPHY
F. C. C. LYNCH, CHIEF

GEOLOGICAL SURVEY

MEMOIR 210

RICE LAKE-GOLD LAKE AREA,
SOUTHEASTERN MANITOBA

BY

C. H. Stockwell



Price, 25 cents

No. 2444

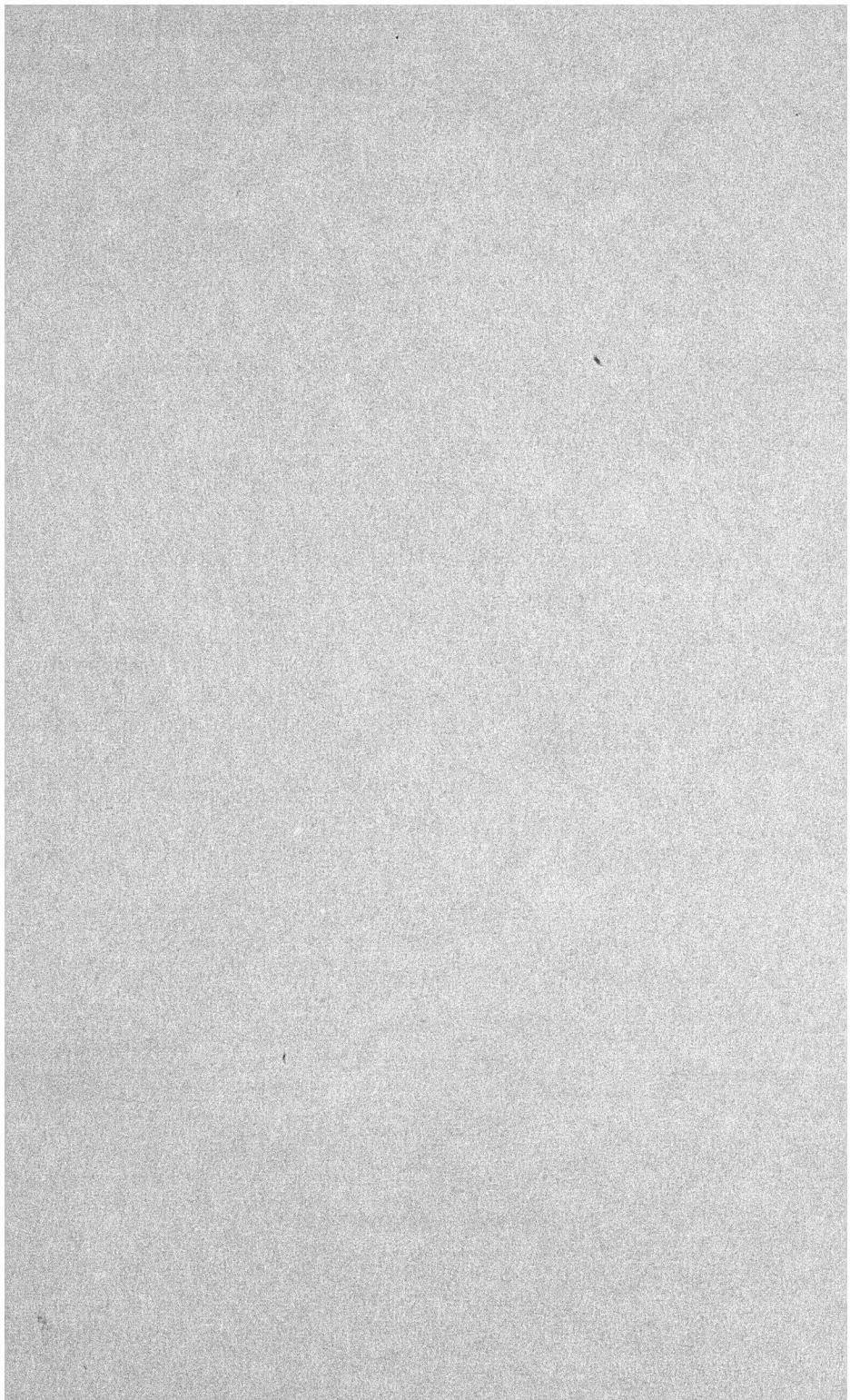
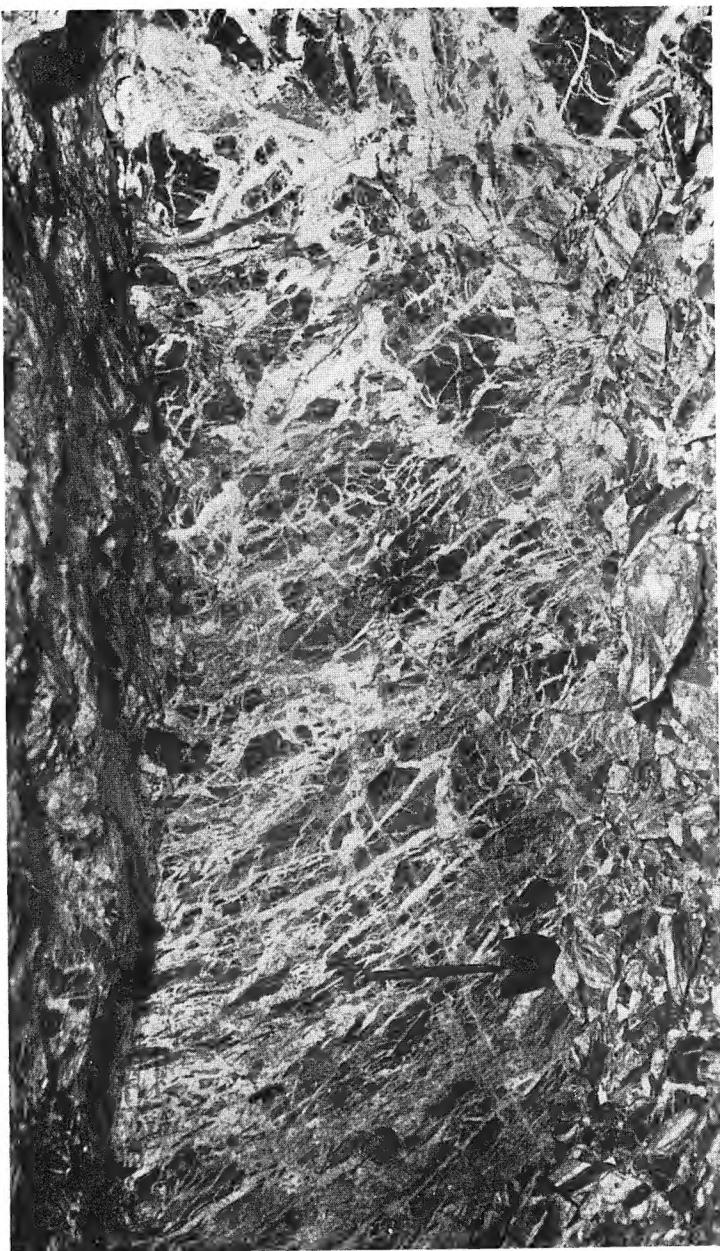


PLATE I



Wide drift face on No. 36 vein, 1,050-foot level, San Antonio mine.

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Rice Lake-Gold Lake Area, Southeastern Manitoba

CHAPTER I INTRODUCTION

The country in the vicinity of Rice Lake, southeastern Manitoba, had been studied and geologically mapped before it became, in 1932, a steady producer of gold.¹ With the worth of the area proved, the Geological Survey decided that a more detailed study was advisable and that such work, in order to be of most assistance toward further development of the area, should comprise geological mapping on a much larger scale than had previously been done. In 1936 the writer covered some 15 square miles in the vicinity of Rice Lake and the San Antonio mine, and the results are presented in this report.

Rice Lake area lies 100 miles northeast of Winnipeg, and 30 miles east of Lake Winnipeg. Except during freeze-up and break-up, a daily air service for transportation of passengers, express, and mail is maintained throughout the year from Winnipeg or Lac du Bonnet to the area, and usually several trips are made each day. During the summer months a bi-weekly boat service for passengers and freight operates from Winnipeg to Rice Lake, the water route being interrupted by only one portage on Wanipigow River and by another between this river and Rice Lake, both of which are crossed by automobile; the journey by this route takes about 20 hours. A winter road extends from the area to Pine Falls, on Winnipeg River, where rail connections are made. The town of Bissett, Manitoba, with a population of about 800 people, has grown up around the San Antonio mine, on the north shore of Rice Lake. Electric power is transmitted to the mine from Great Falls on Winnipeg River. Telephone service from Bissett connects with Winnipeg and other points.

Interest in the area as a prospecting field began in 1911 when gold was discovered on the Gabrielle claim on the north shore of Rice Lake. Other deposits were soon found on the nearby San Antonio claim and elsewhere in the area, and several small scale mining operations were then attempted, without success. It was not until 15 years after the date of the original discovery that underground exploration was com-

¹ Moore, E. S.: Region East of the South End of Lake Winnipeg; Geol. Surv., Canada, Sum. Rept. 1912, pp. 262-270.

De Lury, J. S.: Mineral Prospects in Southeastern Manitoba; Manitoba Bull. 1920, pp. 11-18.

De Lury, J. S.: The Mineral Resources of Southeastern Manitoba; Industrial Development Board of Manitoba, 1927.

Cooke, H. C.: Geology and Mineral Resources of Rice Lake and Oiseau River Areas, Manitoba; Geol. Surv., Canada, Sum. Rept. 1921, pt. C, pp. 1-35.

Wright, J. F.: Rice Lake Map-Area, Southeastern Manitoba; Geol. Surv., Canada, Sum. Rept. 1922, pt. C, pp. 45-73.

Wright, J. F.: Geology and Mineral Deposits of a Part of Southeastern Manitoba; Geol. Surv., Canada, Mem. 169 (1932).

Wright, J. F.: Geol. Surv., Canada, Map 195A, 1927.

menced on the San Antonio claim and led, after several years of persistent effort, to the making of a mine now being operated by San Antonio Gold Mines, Limited. Milling at this mine commenced May 1, 1932, and has continued since that time, with a production up to the end of 1936 of nearly \$4,000,000. Encouraged by favourable developments on this property and by the high price of gold, prospecting interest was revived in the area in 1934 and 1935, but up to the end of 1937, when activity had again reached a low level, no other mines had been brought into production.

Bedrock is generally well exposed in the area, rock hills and plateaux rising to a general level of 100 or 150 feet above Rice Lake (See Plate II A). North and south of the lake, hills and ridges rise to almost this height above nearby valleys, but to the east and southeast the relief is commonly much less. A large part of the area was burnt over many years ago and, although now thinly forested with small second growth, presents clean rock exposures excellent for geological study. Some parts, notably a large area northeast of the lake, are more heavily timbered and much of the rock is covered with moss.

Glacial striæ are preserved on many outcrops, and indicate that the continental ice-sheet of Pleistocene time moved south 60 degrees west. On the retreat of the ice thick deposits of glacial drift and clay were left in the valleys.

The writer is grateful for assistance given by officers of mining companies interested in the area. That part of the report dealing with the details of the San Antonio mine is due to the helpful co-operation of Mr. D. J. Kennedy, manager of San Antonio Gold Mines, Limited, and Mr. G. L. DeHuff, geologist for the same company. Valuable information was also given by officers of Wingold Mines, Limited, Bissett Gold Mines, Limited, Ranger Gold Mines, Limited, Rice Lake Gold Mines, Limited, and Normandy Gold Mines, Limited. The Manitoba Department of Mines and Natural Resources supplied claim maps and the names of the claim owners. Assistance in the field work was rendered by Messrs. D. M. E. McLarty, E. N. Vrooman, O. H. Bjarnason, S. V. Antenbring, D. A. Bowles, G. P. Crombie, J. C. Gibson, R. B. Graham, W. S. Lint, W. R. Livingston, W. A. Morrice, J. P. McHaffie, and C. H. White.

CHAPTER II
GENERAL GEOLOGY
GENERAL STATEMENT

All the consolidated rocks in the vicinity of Rice Lake are Pre-cambrian. In 1912 they were divided by Moore¹ into two series, namely, the Rice Lake series, consisting of volcanic rocks, and the Wanipigow series, composed of sediments; it was inferred that the sediments were younger than the volcanic rocks and were probably separated from them by an unconformity. Most of the granite of the district was found to be younger than the sediments and, although many pebbles of granite were found in the Wanipigow conglomerate, no body of pre-Wanipigow granite was recognized.

In subsequent, more detailed work by Cooke² and Wright³ it was found that some of the sediments were conformable with the lavas, no marked unconformity was recognized, and the whole assemblage was called the Rice Lake series. Wright divided his Rice Lake series into three phases, namely, from oldest to youngest, the Manigotagan phase of sediments, the Beresford Lake phase of dominantly volcanic rocks, and the Wanipigow phase of sediments. Moore's Wanipigow series, accordingly, was thought to be partly older and partly younger than the lavas.

The writer found that, although some of the sediments are conformable with the lavas, other sediments overlie these sediments and the lavas with a marked structural unconformity; therefore, the rocks are again divided into two. The name Rice Lake series is retained for the lavas and interbedded sediments and a new name, the San Antonio formation, is used to designate the younger sediments. Within the small area studied no bodies of granite or other intrusive rocks were found to cut the San Antonio formation. These sediments are undoubtedly younger than porphyry dykes and other intrusives that have been injected into the Rice Lake series near the contact with the San Antonio sediments. If the porphyry dykes near the contact are the same age as others that emanate from a large body of quartz diorite at some distance from the contact, and there is no good evidence to show that they are not the same age, then the San Antonio sediments are younger than the quartz diorite and are the youngest rocks in the map-area. Although there is no conclusive evidence to show that the two groups of porphyry dykes differ in age from one another, those dykes near the San Antonio formation are more sheared and altered and may possibly be older than those that have been derived from the large body of quartz diorite. In the following

¹ Moore, E. S.: Geol. Surv., Canada, Sum. Rept. 1912, pp. 263-265.

² Cooke, H. C.: Geol. Surv., Canada, Sum. Rept. 1921, pt. C.

³ Wright, J. F.: Geol. Surv., Canada, Sum. Rept. 1922, pt. C, p. 45. Geol. Surv., Canada, Mem. 169. Geol. Surv., Canada, Map 195A.

table of formations the San Antonio sediments are shown as younger than all the intrusive rocks, but it should be born in mind that the relations of these sediments to the quartz diorite and related dykes are unknown.

Table of Formations

<i>San Antonio formation</i>
Feldspathic quartzite
<i>Intrusive rocks</i>
Aplite and pegmatite dykes
Porphyry, rhyolite, and andesite dykes
Lamprophyre dykes
Quartz diorite
"Quartz-eye granite"
Meta-diabase sills and dykes
Meta-gabbro, meta-diorite, quartz diorite
Porphyritic andesite sills and dykes
<i>Rice Lake series</i>
Trachyte breccia, porphyritic dacite breccia
Porphyritic andesite
Basalt
Tuff, arkose, conglomerate
Porphyritic basalt
Rhyolite, trachyte, andesite, breccia
Porphyritic andesite breccia

The rocks of the Rice Lake series (See Figure 1 and Maps 458A-465A) are extensively exposed north, south, and east of Rice Lake. They have been tilted for the most part into a northerly dipping monocline, but this structure is complicated toward the east by a broad easterly pitching syncline and possibly other folds. The lowest exposed members of the series outcrop south and southeast of Rice Lake, and comprise interlayered bands of porphyritic andesite breccia and rhyolitic lava. These rocks are overlain by rhyolite mixed with small amounts of trachyte, andesite, volcanic breccia, and porphyritic basalt, as exposed over a large area about Independence Lake. The rhyolite and associated rocks are followed to the east by porphyritic basalt lava and breccia which outcrop around Gold Lake. The basalt has been folded into a broad easterly pitching syncline and is apparently overlain to the east by rhyolite lava and breccia. At a few localities thin beds of tuff, chert, and iron formation extend for short distances along contacts between flows of the above-mentioned rocks. The rhyolite south of Rice Lake and around Independence Lake is overlain to the north by a broad band of sediments interlayered with basaltic lava and a small amount of rhyolite.

The structural relationship between the rhyolite around Independence Lake and the overlying sediments and lavas is uncertain and, as discussed fully in the chapter on structural geology, two interpretations are possible. One possibility is that the rhyolite north and northeast of Independence

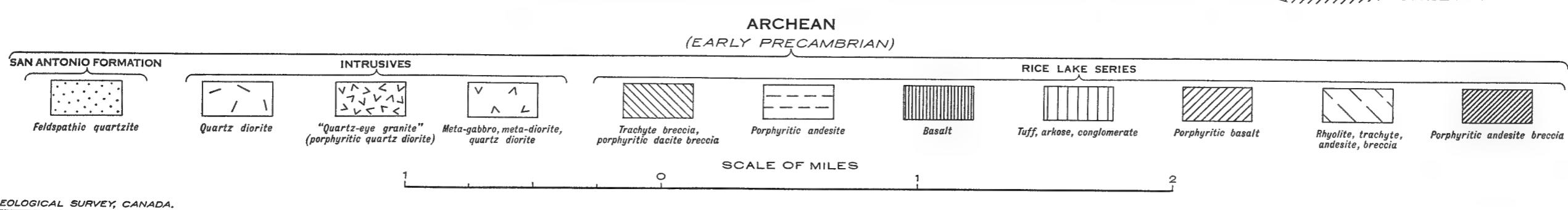
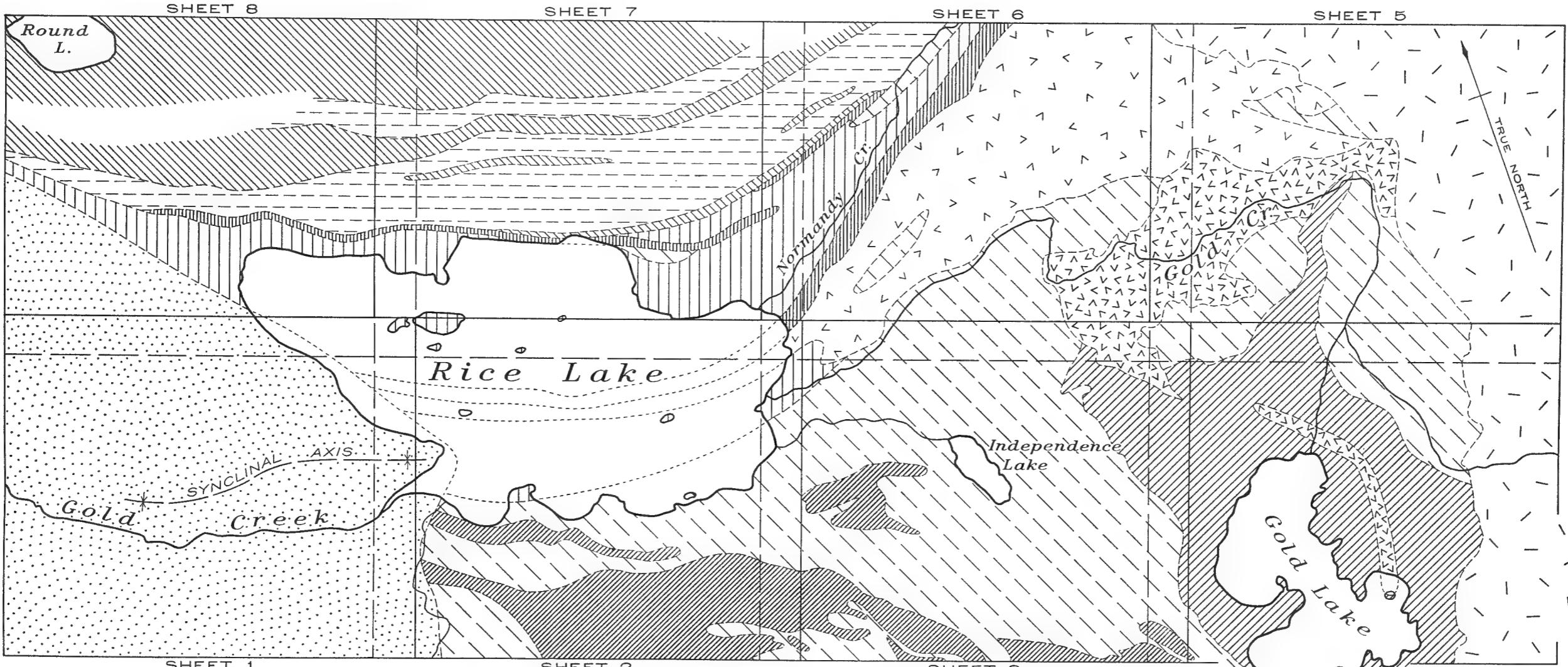


Figure 1. Generalized plan of Rice Lake-Gold Lake area, showing general geology.

Lake passes northerly from the broad syncline about Gold Lake into an anticline and dips conformably beneath the overlying sediments. If such an anticline exists, the porphyritic basalt, which does not appear on the north limb, must either pinch out or be destroyed in a large body of meta-gabbro and related intrusive rocks that lies along much of the contact between the rhyolite and overlying sediments and lavas. Both the syncline and the assumed anticline could pass to the west, toward Rice Lake, into a northerly dipping monocline. The other possible explanation is that the sediments overlie the rhyolite unconformably, in which case it is unnecessary to assume the anticlinal structure or the pinching out of the porphyritic basalt. Although the sediments carry boulders and pebbles of rhyolite and porphyritic andesite like the underlying rocks south and east of Rice Lake, and may have been derived from these rocks, there is no good evidence for a structural unconformity or even a prolonged erosion interval.

The overlying sediments consist very largely of tuffaceous material, but include beds of arkose and conglomerate as well. The sediments are commonly well bedded, but crossbedding was not observed. The basaltic lava shows pillow structure at several localities. The sediments and associated lavas are overlain to the north by alternating bands of porphyritic andesite and trachyte breccia.

Various kinds of intrusive rocks have invaded the Rice Lake series. What are probably the oldest intrusives consist of sills and dykes of porphyritic andesite. This rock resembles the porphyritic andesite lava and volcanic breccia, and it may be an intrusive phase of these rocks. Northeast of Rice Lake the lavas and sediments have been invaded by a large body of hornblende-rich rock varying from meta-gabbro to quartz diorite in composition. The lavas, sediments, and sills of porphyritic andesite are cut by several sills and dykes of altered basic rock which may be called meta-diabase. This rock resembles somewhat closely the meta-gabbro and quartz diorite, but seems to be somewhat younger, for the large body of meta-gabbro, meta-diorite, and quartz diorite is apparently cut by a dyke of the meta-diabase. The meta-diabase is of special interest because almost all the ore that has been produced from the area came from veins in this rock. Also apparently younger than the gabbro and quartz diorite is an irregular-shaped stock and a few dykes of porphyritic rock, which are characterized by phenocrysts of feldspar and large eyes of quartz and which may be called "quartz-eye granite." At the east end of the area a large body of quartz diorite cuts the lavas, gabbro, and "quartz-eye granite." Several dykes of quartz diorite branch outwards from the edges of the main body of quartz diorite, and some of these pass gradually along their strike into feldspar porphyry and quartz-feldspar porphyry. Other dykes of similar porphyries and of fine-grained andesitic rock like the porphyry but without phenocrysts cut the lavas and other rocks east of Independence Lake or cut the quartz diorite itself. All these dykes are no doubt closely related in origin to the large body of quartz diorite, as are also a few small dykes of lamprophyre and numerous small dykes of aplite and pegmatite. Another group of porphyry dykes lies west of Independence Lake and has apparently been derived from a granitic body somewhere south of the map-area. These

dykes are most numerous and largest south of Rice Lake, near their assumed source; to the northeast they become smaller, less plentiful, finer grained, and, at some localities, lose their porphyritic texture and consist of rhyolite. These dykes are more acidic, are more schistose and altered, and may be older than the porphyry dykes that are associated with the large body of quartz diorite at the east end of the area.

The sediments of the San Antonio formation lie west and southwest of Rice Lake. They consist of feldspathic quartzite which, at a few localities, carries well-rounded pebbles of red granite, quartz, and rhyolite, and a few angular fragments of schist. Crossbedding is common. The quartzite has been folded into a broad syncline with a gently dipping south limb and an overturned north limb.

The age relationship and unconformity between the Rice Lake series and the San Antonio formation is shown along Red Rice Creek, southwest of Rice Lake, where the contact between the quartzite and the volcanic rocks strikes about north. In approaching the contact, the beds in the south limb of the syncline of San Antonio quartzite swing northeast and then north so as to strike about parallel to the contact and nearly at right angles to the easterly trending lavas of the Rice Lake series, rather than being interfingered with the lavas, as concluded by Wright.¹ The contact is not a fault, for there is no shearing or brecciation at the one locality where the contact is exposed; there the quartzite lies against porphyritic andesite breccia and consists of the normal medium-grained quartzite even at the edge of the volcanic rock.

As already stated, intrusive rocks, although abundant in the rocks of the Rice Lake series, have not been noted in the San Antonio quartzite within the map-area. South of Rice Lake sills and dykes are plentiful, even close to the contact of the quartzite; many of them strike toward the contact and would be expected to cut the quartzite if they were younger than this rock. Although none of the intrusives was seen to be cut off by the sediments, the intrusive bodies of porphyritic andesite, meta-gabbro, meta-diabase, and the presumably older group of porphyry dykes are, no doubt, older than the San Antonio sediments.

Although these porphyry dykes were probably derived from a body of granitic rock older than the sediments, and the granite pebbles in the sediments also originated from an older granite, no body of pre-San Antonio granite has been definitely recognized. In this connection it is interesting to note that, west of Red Rice Lake, which lies south of the map-area, Wright found that sediments, which apparently belong to the San Antonio formation, are in contact with a body of granite. He states that the sediments along the contact are so little disturbed or altered as to suggest that the beds have been deposited on top of the granite, and that a rock close to the margin of the granite and consisting of angular fragments of granite in a sedimentary matrix might also be interpreted as having been deposited on the granite. Farther to the west, however, a dyke of granite from the granite body penetrates the sediments.² As already stated, if all the porphyry dykes of the area

¹ Wright, J. F.: Geol. Surv., Canada, Mem. 169, pp. 30-31.

² Wright, J. F.: Geol. Surv., Canada, Mem. 169, pp. 29, 44.

are of one age then the San Antonio sediments are younger than a large body of quartz diorite and related dykes in the east part of the area, and are also younger than a body of "quartz-eye granite" that is cut by those dykes.

Descriptions of the various rock types follow.

RICE LAKE SERIES

PORPHYRITIC ANDESITE BRECCIA

Large and small bodies of porphyritic andesite breccia occur along and near the south edge of the map-area from Red Rice Creek easterly nearly to Gold Lake. At some localities the rock is schistose, but more commonly it is massive and forms rounded, hummocky outcrops. It is a fine-grained, greenish grey rock carrying phenocrysts of white feldspar generally about one-sixteenth inch across. Weathered surfaces are brown, and are rough due to protuberances of the small phenocrysts. Almost everywhere the rock is a breccia composed of angular fragments of porphyritic andesite with indefinite boundaries, lying in a groundmass of porphyritic andesite that is similar to the material of the fragments except for a somewhat finer grain. In schistose phases the fragments are elongated parallel to the cleavage of the rock. In some outcrops the fragments are only an inch or two across, whereas at other places they vary from an inch to a foot in size. At a few localities the porphyritic andesite breccia holds angular blocks and round bombs of light grey rhyolitic rock up to 1 foot in diameter.

As seen in thin section under the microscope, the phenocrysts of the porphyritic andesite fragments and matrix vary from albite to andesine and show well-shaped crystal outlines, although commonly considerably altered to a mixture of sericite, carbonate, and zoisite. The phenocrysts lie in a fine-grained groundmass of plagioclase mixed with many tiny flakes of chlorite and biotite and small grains of carbonate, zoisite, and epidote. A few specimens hold rare small phenocrysts of quartz.

The porphyritic andesite breccia is interbedded with layers of dominantly rhyolitic lavas, described in the following paragraphs, and together with the associated rhyolite constitute the lowest members of the Rice Lake series within the map-area.

RHYOLITE, TRACHYTE, ANDESITE, AND BRECCIA

Extensive areas south and east of Rice Lake are underlain by rhyolitic and more basic lavas and volcanic breccia. Several small bodies of similar material lie northeast of the lake, where they form inclusions in gabbro or are interstratified with sediments and basalt.

The dominant type, as typically exposed in the vicinity of Independence Lake, is light grey to greenish grey, and is probably rhyolite or trachyte. Other types are dark grey and are andesites. These light- and dark-coloured lavas are generally massive, very fine grained, and break with a conchoidal fracture. In many outcrops the rock is crossed in several directions by closely spaced joints and, consequently, breaks into small, angular pieces. Weathered surfaces are smooth and are commonly of

lighter shades than the fresh rock. Small flakes of chloritic material can be seen in some specimens of trachytic rock. Pillow structure is developed in one small area. As seen in thin section under the microscope, these rocks are composed chiefly of very fine-grained, light-coloured constituents, apparently entirely of feldspar in some specimens and a mixture of quartz and feldspar in others. The light-coloured constituents are commonly associated with numerous tiny flakes of chlorite. Alteration to zoisite, epidote, carbonate, and sericite is characteristic.

In places, light grey, fine-grained lavas are porphyritic, with small phenocrysts of feldspar and a few of quartz. In these types the ground-mass is commonly much like the material of the grey, non-porphyritic types, although in one specimen lath-shaped phenocrysts of plagioclase lie in a groundmass that has a graphic texture.

The volcanic breccia occurs as large and small, irregular-shaped areas and bands lying in the light-coloured lavas. The fragments vary from an inch or less to 4 feet across. They are commonly sharply angular and roughly equidimensional, although in some highly schistose phases they have been squeezed into long streaks and lenses. The matrix is generally of light grey rhyolitic material and the fragments are of a variety of darker coloured volcanic materials, including fine-grained, grey, non-porphyritic and porphyritic types, black andesite, and black porphyritic basalt. At some localities fragments of grey rhyolitic rock lie in a matrix of dark green chloritic basalt. Associated with the angular fragments are a few rounded bombs of light grey rock and, rarely, small round pebbles of blue and black cherty material and quartz. At distances of 1,000 feet or less from the edge of a large body of granitic rock at the east end of the map-area the minerals of the groundmass and fragments have been recrystallized and the rock is coarser grained than normally.

Iron formation was seen at one place in the map-area, along the north contact between porphyritic andesite and rhyolite in the central part of the Rex No. 1 claim, just west of Independence Lake. It is up to 1 foot thick and consists of rusty weathering black schist carrying much magnetite. It forms a bed in grey and buff cherty sediment.

The large body of rhyolite and more basic lavas and breccia about Independence Lake is interlayered with a few small flows of black, porphyritic and non-porphyritic basalt, which have not been mapped separately, and is overlain to the east by a large body of porphyritic basalt outercropping in the vicinity of Gold Lake. The large body of porphyritic basalt is, in turn, apparently overlain by rhyolite, trachyte, and volcanic breccia. The porphyritic basalt is described below.

PORPHYRITIC BASALT

This rock forms small flows interbedded with rhyolitic lava, as already mentioned, and outcrops as a large irregular-shaped mass in the vicinity of Gold Lake. The west and north contacts of the large body are generally quite definite; toward the east, however, no sharp line can be drawn between the porphyritic basalt and the apparently overlying, lighter coloured rhyolite, trachyte, and volcanic breccia. On the Rita 10 fraction

a narrow dyke of the basalt cuts rhyolite and merges with the main body of basalt lava.

The porphyritic basalt is a very fine-grained black rock holding numerous phenocrysts of white feldspar up to one-sixteenth inch across and commonly arranged in small clusters. Large areas of the rock are massive. At many localities, however, the porphyritic rock occurs as angular fragments, rounded bombs, and irregular-shaped masses, lying in a matrix of black, fine-grained, non-porphyritic rock like the groundmass of the porphyritic basalt. Microscopic examination shows that the porphyritic rock consists of lath-shaped phenocrysts of labradorite and andesine lying in a groundmass of small plagioclase crystals mixed with small crystals of hornblende and chlorite. The feldspar is slightly altered to sericite, carbonate, and zoisite. A few small grains of dark-coloured quartz are present.

The rock is considerably altered by contact metamorphism along and near the edge of the large body of quartz diorite east of Gold Lake. The rock at this locality is a volcanic breccia and the fragments maintain their identity up to the quartz diorite contact, but become less distinct in outline. The effect of the quartz diorite is noticeable at distances of as much as 1,500 feet from the contact, where the groundmass becomes somewhat more coarsely crystalline and many small flakes of biotite take the place of chlorite. Closer to the contact the feldspar phenocrysts become larger, and round phenocrysts of quartz are commonly seen. The quartz phenocrysts, in places, are as much as one-quarter inch in diameter. Within 10 or 20 feet of the contact the rock is commonly grey, has a granitic appearance, and crystals of hornblende and biotite are recognizable without the aid of a lens. At one locality close to the contact numerous small red garnets are developed.

TUFF, ARKOSE, AND CONGLOMERATE

The rhyolitic lavas south and southeast of Rice Lake are overlain to the north by a broad band of tuff, arkose, and conglomerate, which, as already mentioned, holds a few interbeds of rhyolite. The tuff, arkose, and conglomerate probably underlie much of Rice Lake and continue to the northeast as a belt that gradually narrows toward the north edge of the map-area.

The conglomerate is well exposed on a point of land on the south shore of Rice Lake and on an island on the west boundary of the Sundog claim. It also occurs as short lenses in arkosic sediments elsewhere. Pebbles and boulders vary from an inch to a foot in diameter and are either well rounded or have been squeezed into thin lenses. Most of them consist of fine-grained, light grey, rhyolitic rock, and a few are of porphyritic andesite, quartz-feldspar porphyry, quartz, and chert. The pebbles and boulders lie in a matrix of green chloritic schist and arkose. Bedding is generally lacking, although in places boulders are more abundant in some layers than in others and the conglomerate has poorly defined stratification.

Arkosic sediment is a common rock of this group and generally forms massive beds 5 feet to 50 feet or more thick. It is a rather coarse-grained,

grey rock weathering light grey to pinkish. Scattered round grains of quartz are generally seen on the weathered outcrops, although grey feldspar greatly predominates. The feldspar is chiefly, if not entirely, plagioclase and is generally much altered to sericite, carbonate, and zoisite. The grains of quartz and feldspar lie in a matrix of fine-grained material composed chiefly of feldspar, sericite, chlorite, carbonate, zoisite, and epidote. Much of the arkose contains scattered round pebbles of rhyolite and a few of quartz.

With increase in the number of rhyolitic pebbles the arkose passes into a coarse-grained, tuffaceous rock composed almost entirely of closely packed, rounded and subangular pebbles and fragments of rhyolite, commonly from one-half to one inch in diameter. This rock also carries scattered pebbles of porphyritic andesite and quartz-feldspar porphyry and a few large fragments of dark schist. The pebbles of rhyolite and other rocks are cemented together by green, schistose, chloritic material with rare grains of quartz. The coarse tuff is well exposed across the middle of Hares Island and on the smaller island to the west, where it forms a bed 150 feet thick.

Much of the arkose is interlayered with beds, 2 feet to 10 feet thick, of well-laminated sediment. The laminations vary from $\frac{1}{4}$ inch to 6 inches wide, and comprise alternating layers of various shades of grey and of various grain size; most of the layers are of very fine-grained material. The laminated sediment may be seen on the south shore of Hares Island and at many places on the Rachel claim. On the Rachel claim several of the laminations vary gradually from coarse grained at one side to very fine grained at the other; the coarse material is tuffaceous, being composed of small grains of feldspar and rhyolitic rock without quartz, and possibly much of the laminated sediment is fine-grained tuff. At a few localities scattered pebbles and boulders of rhyolite up to 1 foot in diameter lie in the fine-grained material.

The pebbles and boulders of rhyolite and porphyritic andesite in the conglomerate and other sediments are like the underlying rocks to the south and east of Rice Lake and may have been derived from these rocks, but as already stated there is no good evidence of an unconformity at the base of the sediments.

The tuff and arkose are interbedded with flows of basalt, described below, and are overlain to the north by interlayered bands of porphyritic andesite and trachyte breccia, described in subsequent paragraphs.

BASALT

Basaltic lava occurs as three long easterly trending bands lying in or adjacent to the tuff and arkose. One band along and near the north shore of Rice Lake has been traced for almost $2\frac{1}{2}$ miles. Another band, outcropping on a high ridge southeast of Normandy Creek, is up to 600 feet wide, is exposed for $1\frac{1}{2}$ miles, and may continue for an equal distance beneath the lake. The third band is shorter and outcrops near the north edge of the sediments northeast of Rice Lake.

The lava is a dark green, fine-grained, schistose rock showing pillow structure at several localities. The pillows are commonly about 1 foot

wide and 2 or 3 feet long. On the high ridge southeast of Normandy Creek, where the lavas are highly schistose, the pillows are much compressed and some of them are $1\frac{1}{2}$ feet long and only 3 inches wide. Lumps of green epidote up to a foot across are scattered here and there through some of the pillowved and non-pillowed lava. At some localities the lava passes across the strike into narrow zones of dark green volcanic breccia. Microscopic examination shows that the highly schistose and more massive phases are chlorite schists with some sericite, carbonate, epidote, and very fine-grained feldspar.

PORPHYRITIC ANDESITE

Two broad easterly striking bands of coarse porphyritic andesite occur north and northeast of Rice Lake. They are interstratified with layers of trachyte breccia and porphyritic dacite breccia. The more northerly of the bands is largely drift covered and its position, for the most part, has been determined by diamond drilling. The southern and wider band is well exposed on high rock ridges for most of its length; it is at least 3 miles long and is up to 2,000 feet wide. The rock varies from massive to schistose and is composed of numerous light grey feldspar phenocrysts in a fine-grained, grey to greenish grey groundmass. Weathered surfaces are grey to brownish and are rough, due to projecting feldspar phenocrysts. The rock resembles the porphyritic andesite breccia already described, except that the phenocrysts are larger and are commonly $\frac{1}{8}$ inch across; some are $\frac{1}{4}$ by $\frac{1}{8}$ inch and others are reported¹ to be $\frac{1}{2}$ inch across.

Much of the rock is breccia, but the brecciated texture is not as common as in the porphyritic andesite breccia. The fragments are up to a foot or more long, are angular or elliptical, and have indefinite edges. Both the fragments and matrix are of porphyritic andesite and resemble one another in general appearance and composition, although the phenocrysts are larger in the fragments than in the matrix. Fragments of fine-grained rhyolitic rock are also present, but are rare.

The phenocrysts are probably of oligoclase or andesine, although their composition is difficult to determine because they are almost completely altered to a mixture of sericite, zoisite, and carbonate. The groundmass consists of very fine-grained material, which is probably feldspar, and which is much altered to zoisite, epidote, and carbonate and mixed with numerous tiny flakes of chlorite and a few of sericite. In schistose phases the phenocrysts are lenticular, and the groundmass holds long, parallel shreds of chlorite and sericite. Small round grains of dark blue quartz also occur in the rock, but are rare. On microscopic examination the round quartz grains are seen to be associated with chlorite and carbonate, and it is possible that the quartz and associated minerals are amygdaloidal fillings.

A large part of the wider band of this rock has been considered to be an intrusive body.² At one locality, just north of the northeast corner of the Mite fraction, the contact between the porphyritic andesite and adjoining trachytic breccia could be interpreted as indicating that the

¹ Wright, J. F.: Geol. Surv., Canada, Mem. 169, p. 82.

² Wright, J. F.: Geol. Surv., Canada, Mem. 169, p. 82. "The San Antonio Mine and Mill", by the Staff; Trans. Can. Inst. Min. and Met. 1936, p. 2.

andesite is intrusive. At this locality the two rocks are interfingered with one another along a crenulated contact that generally trends northeasterly at a considerable angle to the general easterly trend of the formations and to the easterly direction of elongation of fragments in the breccia, giving the impression that the andesite crosses the structure of the breccia. However, the fragments are elongated parallel to the direction of schistosity, and their attitude does not eliminate the possibility that the contact is conformable. Elsewhere, the nature of the contacts with adjoining trachytic breccia, as described below, indicates that the rock is more probably a lava. If so, the larger body probably comprises several flows; no flow contacts have been observed within the andesite, although two long narrow lenses of trachyte breccia lying within the large body, as shown on Maps 463A and 464A, apparently lie between flows of the porphyritic andesite. The noteworthy contact relationship is that the trachyte breccia from 1 foot to 10 feet from the north edge of the porphyritic andesite carries scattered angular and lenticular bodies of porphyritic andesite identical in grain size and appearance with the rock of the main body, and no doubt derived from it. This relationship is seen wherever the contact is exposed for 3 miles along the north edge of the main body, and for a shorter distance along the north contact of the main body with the lens of trachyte breccia that lies north of Rice Lake. Because of their coarse, porphyritic nature, the fragments are easily distinguishable from the numerous fragments of fine-grained volcanic rock that comprise the bulk of the trachyte breccia. Where the trachyte is schistose and has been much compressed all the fragments, including those of porphyritic andesite, are lenticular, and in such cases, were it not for other evidence, the porphyritic bodies could be considered as injections. At some localities, however, the porphyritic bodies are sharply angular or subangular and the injection hypothesis seems untenable (See Plate II B). Moreover, the north edge of the main body of porphyritic rock, although straight for short distances at some localities, is commonly irregular, as if the trachyte breccia were deposited on an irregular, fragmental surface.

The southern, or bottom, contacts of the porphyritic andesite are generally straight and sharply defined, as in the southern part of the Goldfield claim, and in the central part of the Gabrielle claim, and the fragmental rocks beneath do not hold fragments of the porphyritic andesite. In the central part of the Emma claim no sharp line can be drawn between the andesite and underlying fragmental rock. At this locality the fragmental rock holds a variety of rounded and angular fragments of volcanic material, including many of porphyritic andesite. The fragments of porphyritic andesite, however, are generally finer grained than the overlying andesite, resemble fragments found elsewhere in trachyte breccia at localities not close to contacts of the porphyritic andesite, and apparently have not been derived from the main body of porphyritic andesite.

TRACHYTE BRECCIA AND PORPHYRITIC DACITE BRECCIA

These rocks are extensively exposed north of Rice Lake, where trachyte breccia forms a long, narrow band separating the two bodies of porphyritic andesite, and occurs as two long lenses within the southern band of

porphyritic andesite. Trachyte breccia also occurs in a broad area farther north, where it is associated with porphyritic dacite breccia.

The trachyte breccia has a poorly developed schistose structure and is generally composed of numerous closely spaced fragments of fine-grained, light grey rock lying in a matrix of fine-grained, grey to greenish grey material similar to the fragments except for a somewhat darker colour. In places, a few scattered fragments of fine-grained rock are of darker colour than the matrix. As already described, the trachyte breccia near the north edge of bodies of porphyritic andesite holds fragments of this rock. Elsewhere a few fragments of finer grained porphyritic andesite also occur. The abundant, light-coloured fragments commonly carry many small, elongated flakes of chloritic material. These fragments vary from an inch or less to 2 feet long, and are elongated in the direction of schistosity. They are generally angular, although in more highly schistose phases they are lenticular. At some localities poorly defined layers a foot or two wide, and carrying small fragments, alternate with layers holding large fragments, giving outcrops a crude bedded appearance (See Plate III A). This bedding strikes easterly, dips steeply north, and lies about parallel to the cleavage.

On microscopic examination the light grey fragments and the matrix are seen to be composed chiefly of very fine-grained feldspar, generally much altered to sericite, zoisite, and small amounts of carbonate. Where not too highly altered the feldspar is seen to be albite. In some specimens the feldspar is mixed with numerous tiny crystals of colourless amphibole, whereas in other specimens it is associated with many small flakes of chlorite. The amphibole crystals and chlorite flakes lie parallel to one another and give the rock its schistose structure.

The porphyritic dacite breccia is well exposed in the vicinity of Round Lake and easterly for $1\frac{1}{2}$ miles from the lake. This rock carries many small phenocrysts of feldspar, and generally holds scattered grains of quartz in a fine-grained, grey to greenish grey groundmass. Except for the presence of quartz the rock is very similar in appearance to the porphyritic andesite and porphyritic andesite breccia already described. Fragments, however, are generally much more sharply defined. These are commonly from an inch to a foot or more across, vary from sharply angular to lenticular, and are somewhat more coarsely porphyritic than the groundmass. The rock apparently passes without sharp contacts into breccia holding fragments of porphyritic andesite, porphyritic dacite, and trachyte, and this rock in turn appears to grade into typical trachyte breccia.

A layer of fragmental rock lying between the southern band of porphyritic andesite and the underlying wide belt of tuff, arkose, and conglomerate carries many angular fragments of acidic volcanic rock like the trachyte breccia, and is mapped as such, although in places the rock resembles a sediment for it carries round pebbles of volcanic rock and a few grains of quartz.

CHERT AND TUFF

Thin lenses of chert and tuff occur here and there along contacts between porphyritic andesite breccia and rhyolite, along contacts between rhyolite and porphyritic basalt, between flows of rhyolite, and, less com-

monly, within areas of porphyritic andesite breccia and trachyte breccia. The lenses are generally only 1 or 2 feet thick and 100 feet or less in length, and are not shown on the map except by strike and dip symbols. The chert varies from white to blue and buff and is thinly laminated. The tuff is also generally thinly bedded and varies from a coarse, gritty rock with angular fragments of volcanic material to a very fine-grained, grey to black, feldspathic rock.

INTRUSIVE ROCKS

SILLS AND DYKES OF PORPHYRITIC ANDESITE

Several long sill-like bodies and dykes of porphyritic andesite occur to the south, east, and north of Rice Lake. They cross various types of lavas and fragmental rock. The largest of these bodies is nearly 2 miles long and is up to 300 feet wide.

The rock varies from massive to schistose and carries phenocrysts of milky white to greenish grey feldspar, in a fine-grained, greenish grey groundmass. The phenocrysts are generally $\frac{1}{8}$ inch or less across, although in some bodies many are $\frac{1}{4}$ inch and a few are $\frac{3}{8}$ inch in size. In schistose phases the phenocrysts are lenticular. Microscopic examination shows that the phenocrysts vary from oligoclase-andesine to albite, are occasionally zoned, and are commonly much altered to sericite and zoisite. The groundmass is of feldspar mixed with numerous tiny flakes of chlorite and is considerably altered to epidote, zoisite, and carbonate. In schistose varieties the groundmass is crossed by long shreds of chlorite, which give the rock a fair cleavage.

The intrusive nature of most of these bodies is shown by crosscutting relationships and by chilling for an inch or two along both walls, the chilled rock being either without phenocrysts or holding phenocrysts of a smaller size than found in the interior of the bodies. The edges of the bodies are usually sharp and straight. The intrusive porphyritic andesite is similar in appearance and composition to the porphyritic andesite lava and breccia already described, except that the intrusive rock generally carries somewhat larger phenocrysts and does not show a brecciated structure. It seems probable that the sills and dykes are intrusive equivalents of the flows and breccia.

META-GABBRO, META-DIORITE, AND QUARTZ DIORITE

This group of rocks forms a large body extending northeast from the east end of Rice Lake. It is about a mile wide near the north edge of the map-area, gradually narrows toward the lake, where it is only 500 feet wide, and apparently continues as a narrow band beneath the lake. Several dykes of rock similar to that of the large body also occur, and one of these branches from the northwest edge of the large body and extends into adjacent basaltic lava.

In the main body, the quartz diorite, gabbro, and diorite grade into one another, and the three types appear to be irregularly distributed. In places at the margins of the body these rocks are fine grained, as if chilled against adjacent sediments and lavas. Within the body they

vary from fine to medium and coarse grained without apparent relationship to the edges of the mass. The quartz diorite predominates. It is a massive, dark green, hornblende-rich rock carrying small and large grains of dark bluish quartz. Weathered surfaces are green or brown. The hornblende is apparently secondary after augite, for remnants of augite remain in the centres of some of the hornblende crystals. The feldspar, which is andesine, is partly altered to sericite, and is mixed with much chlorite and epidote.

The gabbro is similar to the quartz diorite in general appearance, except that quartz is lacking or occurs only as rare, small, scattered grains. In places the gabbro and quartz diorite carry abundant magnetite and scattered specks of pyrite.

The diorite is a brown weathering, light grey rock composed chiefly of andesine, which is much altered to carbonate, sericite, and zoisite.

Here and there near the south contact of the main body the fine- and medium-grained, hornblende-rich rock carries numerous, roughly equidimensional crystals of milky white material, commonly from $\frac{1}{4}$ to $\frac{1}{2}$ inch across. These were possibly feldspar, but are so much altered to zoisite, carbonate, and sericite that their identity is obscured.

META-DIABASE

This rock occurs as dykes and sills cutting the lavas and sediments of the Rice Lake series and the intrusive porphyritic andesite. One dyke apparently also cuts the main body of meta-gabbro, meta-diorite, and quartz diorite that extends northeast from Rice Lake, as described above. The rock closely resembles the finer grained quartzose phases of this large body and may be closely related in origin to it. In addition to the dykes shown on the map several small dykes occur in the sediments and porphyritic andesite lava.

The meta-diabase is a medium- to fine-grained, dark green rock which is generally massive, although in some places it is schistose. Small dykes are finer grained than large ones, and the large dykes are locally chilled against the invaded rocks. Small, scattered grains of dark blue quartz can be seen in some hand specimens, and small, irregular-shaped grains of quartz occur in all the thin sections examined. Feldspars vary from albite-oligoclase to labradorite, and are commonly much altered to zoisite, epidote, and carbonate, and in some sections are apparently entirely altered to these minerals. The feldspars are lath-shaped and penetrate the grains of quartz, giving these grains an irregular shape. Pale green hornblende is commonly plentiful and occurs as large and small, fibrous crystals. All sections in addition to abundant epidote and carbonate show much chlorite, and schistose phases are essentially chlorite schists. Magnetite and leucoxene are common accessories. One section contains much micropegmatite filling spaces between laths of plagioclase. The original texture of the rock is obscured by alteration products, and even the hornblende appears to be secondary. Diabasic texture has, accordingly, not been observed, but the lath-shaped character of the feldspar and the presence of micropegmatite, which is common in diabase, suggest that the rock may have been quartz diabase originally.

"QUARTZ-EYE GRANITE"

This rock occurs as a large, irregular-shaped body north of Gold Lake and as three dykes nearby. The "quartz-eye granite" invades porphyritic basalt and rhyolitic lavas. It apparently also intrudes the large body of gabbro and related phases that extends northeast from Rice Lake, for the mapping shows that it bulges into the gabbro. Close to the contact the granite holds a few small inclusions of dark rock that may have been derived from the gabbro. The evidence is not conclusive, for at some localities the gabbro is fine grained for 2 feet from the contact, suggesting that it is chilled against the granite. At other places, however, the gabbro is coarse grained at the contact. The granite shows no appreciable change in grain size as the gabbro is approached.

The "quartz-eye granite" is a massive grey rock weathering grey to brown. It is composed of closely spaced crystals of white feldspar and scattered round "eyes" of blue and white quartz lying in a fine-grained, dark grey groundmass. The feldspar crystals are euhedral and are generally uniformly about one-sixteenth inch across, although a few are twice that size. The quartz "eyes" vary in size, but are commonly larger than the feldspars and many are three-sixteenths inch in diameter. The feldspar varies from oligoclase to andesine, commonly shows zonal growth, and is partly altered to sericite and zoisite. The groundmass is a very fine-grained mixture of quartz, feldspar, biotite, hornblende, chlorite, zoisite, epidote, and carbonate with, in places, accessory magnetite and apatite. The rock is much like the "quartz-eye granite" in Herb Lake area,¹ northern Manitoba.

QUARTZ DIORITE

This rock forms a large body in the eastern part of the map-area. The contact of the body crosses various types of lavas; gabbro, "quartz-eye granite," and dykes of quartz diorite branch outwards from the edge of the main body and extend for short distances into each of these rock types. A few small, outlying bodies of quartz diorite also occur in the lavas.

The quartz diorite is massive, light grey to pinkish grey, and is commonly quite coarse grained even at contacts with invaded rocks. The feldspar is almost entirely plagioclase, varying from oligoclase to andesine, in places showing zonal growth and being only slightly altered to sericite and zoisite. Small amounts of microcline occur in some specimens. Quartz, hornblende, and biotite are abundant constituents, and magnetite and apatite are accessory. Hornblende is generally more plentiful than biotite, although at some localities the reverse is true. At a few localities the rock is porphyritic with phenocrysts of feldspar up to three-eighths inch across.

Contact metamorphic effects on rhyolite and porphyritic basalt have already been described.

DYKES OF PORPHYRY, RHYOLITE, AND ANDESITE

Numerous dykes of porphyry and a few of rhyolitic rock occur south and east of Rice Lake, but are rare to the north of the lake. The dykes may be divided on the basis of distribution and lithological character into

¹ Geol. Surv., Canada, Mem. 208, pp. 9-10.

two distinct groups, called the west group and the east group. The dividing line between the two groups passes through Independence Lake and extends about south from the lake and about north 30 degrees east from the lake (See Figure 2). Nowhere were the dykes of one group found in contact with those of the other, but those of the west group are schistose and altered and may be older than the dykes of the east group which are massive and fresh.

The dykes of the west group generally strike northeast in the area south of Rice Lake and, toward the northeast, gradually change in direction so as to trend northerly in the area east and northeast of the lake. South of the lake they are most abundant and largest, and the texture of some of the larger bodies approaches that of a granite. East of the lake the dykes are fewer in number and toward the north, between Gold Creek and Normandy Creek, become quite small and are, for the most part, of fine-grained rhyolitic rock without phenocrysts. North of Rice Lake, the dyke crossing the Emperor and Gold Reserve No. 5 claims is of porphyry, whereas the one crossing the Rachel claim is of rhyolitic rock. Several dykes have been found in the underground working in the diabase sill on the north shore of Rice Lake and beneath the lake. These strike from east to northeast and are commonly of rhyolitic material, although one dyke holds large phenocrysts of albite.

The decrease in the number and size of the dykes and the general change from granitic to porphyritic and finally to rhyolitic texture strongly suggest that the dykes were derived from a granitic body somewhere south of the map-area. Small bodies of granite do occur just southeast of Red Rice Lake and one-half mile south of the map-area,¹ but their relationship to the dykes has not been studied closely.

The porphyry dykes of this group are commonly somewhat schistose, and in places are altered to sericite schist. The phenocrysts are of grey to pink feldspar and of round eyes of white and bluish quartz up to three-sixteenths inch in diameter. In most dykes feldspar phenocrysts are more plentiful than those of quartz, and in some dykes quartz phenocrysts are lacking. The feldspar phenocrysts vary from albite to oligoclase, generally show poorly formed crystal outlines, and are much altered to sericite, carbonate, and zoisite. The groundmass is light grey to greenish grey, and is composed of a fine-grained mixture of acid plagioclase, quartz, chlorite, sericite, carbonate, and epidote. The chlorite and sericite form small flakes and shreds generally lying about parallel to one another and giving the rock its schistose structure.

The rhyolite is a light grey to greenish, schistose rock with the general appearance and composition of the groundmass material of the porphyry dykes, although the felsic constituents in some of the rhyolite dykes show a micrographic texture. Small, poorly defined phenocrysts of feldspar are occasionally seen with the aid of a microscope.

The dykes of the east group cut the large body of quartz diorite at the east end of the area, but are more numerous and larger in the nearby older intrusives and lavas. In these older rocks the dykes strike northerly. Near the north edge of the map-area several of the dykes branch outwards

¹ Geol. Surv., Canada, Map 195A.

from the edge of the large body of quartz diorite. For a short distance from the edge of the large body the dykes are of non-porphyritic quartz diorite like the rock of the parent body, but farther south they merge into coarse porphyry. These branch dykes are widest at their source, gradually become narrower to the south, and finally pinch out. Other dykes lie parallel to those that can be traced into the quartz diorite and are probably offshoots from the same body at depth. These vary in width and grain size and are commonly of porphyry, although a few are of fine-grained, non-porphyritic andesite. In addition to the dykes, large, irregular-shaped bodies of porphyry occur on the south shore of Gold Lake and a short distance northeast of the lake.

The porphyry dykes of this group are massive, dark grey rocks holding conspicuous phenocrysts of white feldspar. The feldspar phenocrysts are commonly about $\frac{1}{4}$ inch across, although many are smaller and a few are $\frac{1}{2}$ inch long. They are commonly of andesine, but vary from oligoclase to labradorite, are generally zoned, exhibit excellent crystal outlines, and are only slightly altered to sericite, zoisite, and carbonate. In addition to the feldspar phenocrysts, round and irregular-shaped grains of white and blue quartz can be seen in some of the dykes. The quartz phenocrysts are less plentiful than those of plagioclase, and are generally much smaller. The dark grey groundmass varies from fine grained to rather coarse grained, and the dark colour is due to the presence of abundant hornblende or biotite or to a mixture of these two minerals. Plagioclase and quartz also occur in the groundmass, and in places these two minerals are graphically intergrown with one another. Small amounts of chlorite, epidote, carbonate, magnetite, apatite, and titanite also occur. The andesite dykes are similar in appearance and composition to the groundmass of the porphyry. Micrographic intergrowths of plagioclase and quartz are more commonly present in the dykes of andesite and fine-grained porphyry than in the bodies of coarse porphyry. The porphyry dykes that cut the large body of quartz diorite strike in various directions, are smaller, and are finer grained than most of the dykes in nearby rocks.

Although most of the dykes appear to be offshoots from the large body of quartz diorite, and are essentially of the same age as this body, the dykes cutting the quartz diorite are evidently somewhat younger, and one of the porphyry bodies on the south shore of Gold Lake is cut by the quartz diorite and is, accordingly, older than that rock. A slight difference in age between the various dykes is also indicated by the fact that, near the south boundary of the Rita 4 claim a dyke of fine-grained porphyry crosses and is chilled against a dyke of coarse porphyry.

LAMPROPHYRE

A few narrow dykes of lamprophyre occur in association with the east group of porphyry dykes. The lamprophyre is a fine-grained, massive, fresh, dark green to black rock, composed chiefly of hornblende with smaller amounts of andesine or labradorite, magnetite, pyrite, and epidote. In one dyke the hornblende forms distinct phenocrysts and occurs in the groundmass as well.

These dykes cut the "quartz-eye granite." They are generally cut by the porphyry dykes, although one dyke of lamprophyre cuts the body of porphyry on the south shore of Gold Lake and is in turn cut by quartz diorite. The lamprophyre dykes appear to be generally about the same age as the associated porphyry dykes and may be related in origin to the large body of quartz diorite at the east end of the area.

APLITE AND PEGMATITE

Innumerable small dykes of aplite and pegmatite cut the lavas, gabbro, "quartz-eye granite," lamprophyre, and porphyry close to the edge of the large body of quartz diorite at the east end of the map-area, and occur in fewer number within this large body. The dykes are especially plentiful in the lavas east of Gold Lake, where they occur for as much as 2,000 feet from the edge of the quartz diorite.

In the quartz diorite they are commonly only a few inches or a foot wide. In the lavas and other rocks they are as much as 70 feet wide, but are mostly much smaller, and form irregular, curved, and branching bodies that cannot be traced along the strike for more than 500 feet and generally much less.

The aplite is a fine-grained pink rock composed of pink feldspar and quartz with small amounts of biotite. The aplite is irregularly mixed with pegmatite, into which it grades. The constituent minerals of the pegmatite include microcline, plagioclase, quartz, and biotite. The feldspar crystals are rarely more than an inch across.

SAN ANTONIO FORMATION

Grey, feldspathic quartzite underlies a large area west and southwest of Rice Lake. The formation has been folded into a broad syncline with an easterly trending axis, a gently dipping south limb, and an overturned north limb. The quartzite varies from massive to schistose and the secondary cleavage strikes about parallel to the axis and dips north regardless of the varying attitude of the beds.

The rock is composed chiefly of quartz, which is mixed with small amounts of plagioclase, microcline, sericite, chlorite, and carbonate. The sericite and chlorite form shreds and small flakes lying roughly parallel to one another and giving the rock its schistose structure. In places, a few round pebbles of quartz, rhyolite, and red granite, $\frac{1}{2}$ inch to 2 inches in diameter, and a few angular fragments of pale green schist are scattered through the quartzite. Almost everywhere, however, the rock is uniformly medium grained, and it is rare to find beds of finer or coarser material alternating with the dominant type.

The rocks show crossbedding at many localities. The cross beds are generally not separated from one another by true beds, but lie one against another. At any one locality the average strike and dip of the cross beds give the approximate attitude of the formation. Bedding lines in each cross bed meet underlying beds tangentially and are cut off by overlying cross beds. Where the cross beds have not been appreciably disturbed or squeezed the lines in each cross bed meet adjacent overlying beds at

angles of only about 20 degrees, as seen in sections normal to the dip of the formation. At many localities the cross beds, as described in the chapter on Structural Geology, are much deformed, as a result of shearing during development of regional schistosity.

The contact between the quartzite and rocks of the Rice Lake series was seen only at a locality 1,700 feet south of the outlet of Rice Lake. At that place, the quartzite lies against porphyritic andesite breccia, dips about vertically at a point close to the contact, and consists of the normal, medium-grained type right up to the edge of the volcanic rock.

CHAPTER III

STRUCTURAL GEOLOGY

GENERAL STATEMENT

The sediments and volcanics of the Rice Lake series, as already stated, appear to be separated from the younger San Antonio formation by a marked angular unconformity. Although the contact between the two groups of rocks is exposed at only one locality, the structural discordance can be seen from the results of the areal mapping.

The rocks of the Rice Lake series, judging from all available evidence, have been folded into a northerly dipping monoclinal structure, complicated toward the east by a broad, easterly pitching syncline and possibly other structures. Tops of the north-dipping beds face north. The San Antonio sediments have been folded into a broad syncline with minor folds on the limbs, but generally with a gently dipping south limb and an overturned north limb. The younger sediments around the east nose of this fold strike across the beds of the Rice Lake series at various angles; along the north limb of the fold the two series of rocks strike and dip about parallel to one another but lie back to back, as exposed on opposite sides of a wide, drift-filled valley which covers the contact. As it is unreasonable to suppose that the Rice Lake rocks were upside down at the time the San Antonio sediments were laid down, it seems necessary to assume that a fault separates the whole or part of the north limb of the sediments of the younger series from the older sediments and volcanics. For such a fault, however, there is little evidence except that the San Antonio sediments near the north edge of the wide, drift-filled valley and south of the diabase sill on the Augustina claim are unusually schistose, as shown in diamond drill cores. It is conceivable that such a fault could continue either easterly through Rice Lake and thence northeasterly along a drift-filled valley occupied by Normandy Creek, just southeast of which the rocks are more schistose than usual, or it could continue beneath the lake close to the southwest shore and thence, as shown on a map by Cooke,¹ through a drift-covered area or through unusually schistose rocks south of the lake to join with a zone of faults extending southeast from the lake.

Much of the rock of both series and of some of the intrusives is schistose over wide areas. This regional cleavage strikes easterly for the most part, crossing many of the beds of the younger sediments but curving so as to follow the structural trend of the older rocks. In all cases the cleavage dips north or is vertical.

Narrow belts of schist, or shear zones, cross the rocks of both series, as well as many of the intrusives. These zones are generally faults, and

¹ Cooke, H. C.: Geology and Mineral Resources of Rice Lake and Oiseau River Areas, Manitoba; Geol. Surv., Canada, Sum. Rept. 1921, pt. C, opposite page 8.

together with fracture zones form a system of two sets trending at wide angles to one another. Vein quartz has been deposited along most of these zones. Further details about the structure are given in the following paragraphs and the veins are described in the chapter on Economic Geology.

FOLDING OF THE RICE LAKE SERIES

The nature of the rock formations of the Rice Lake series is such that determination of folding is most difficult. This is due especially to a general scarcity of sedimentary beds or flow contacts that give the strike and dip, and to the small number of distinctive features that give top determinations. South and east of Rice Lake, an attempt has been made to map some of the larger bodies of more or less distinctive rock types and the result, it is believed, assists toward an interpretation of the structure there. North and northeast of the lake there are more apparent differences in the formations, and the mapping of the various rock types reveals the structural trend. Apart from a broad band of sedimentary material extending through Rice Lake and northeasterly from the lake, sediments are rare, but a few thin short bands have been found between flows and these are useful in giving strike and dip and, rarely, in showing tops.

The available evidence indicates that the formations north and south of Rice Lake strike slightly south of east and dip and face northerly, but when traced easterly along the strike they diverge from one another and leave between them, in the country east of Rice Lake, a broad, wedge-shaped area where the nature of the folding is incompletely known, but consists in part of a broad, easterly pitching syncline.

The formations south and southeast of the lake consist of interlayered bands of porphyritic andesite breccia and rhyolitic rock which trend on the average about 30 degrees south of east. Thin, sedimentary layers between lava flows dip from 15 to 70 degrees northerly, with gentle dips predominating. Tops of the beds of volcanic and sedimentary rocks face northerly, as determined at two localities. One of these localities is on the south part of the Golden Star No. 1 claim, where thin layers of well-laminated chert lie in porphyritic andesite. The north-facing surface of one of the sedimentary layers had been partly eroded away before the deposition of the overlying layer of andesite, so that the contact is irregular and in places crosses the laminations of the chert in such a way as to resemble crossbedding. The other place where top has been determined is near the southeast boundary of the Ranger claim, where a northerly dipping lava flow is brecciated along its north edge and is overlain by another flow which holds scattered fragments of the underlying flow for 10 feet from the contact, as if picked up from the brecciated surface.

The lavas south and southeast of Rice Lake are overlain to the northeast by the rocks in the broad, wedge-shaped area east of the lake. In this area rhyolite and more basic lavas outcrop as a wide band extending northeast and southeast from Independence Lake and forming the westerly pointing, V-shaped part of the wedge. These lavas are overlain to the east by porphyritic basalt which, together with a layer of rhyolitic material still farther east, fills the remainder of the wedge.

Because of the scarcity of sedimentary beds or other features that give the strike and dip of the formations, the character of the folding in the wedge-shaped area is incompletely known. However, some irregular folding has apparently taken place just west of Independence Lake, judging from the shape of a small body of porphyritic andesite breccia at that locality. The porphyritic basalt and nearby rhyolitic lavas north of Gold Lake appear to have been folded into a broad, easterly pitching syncline with limbs extending nearly at right angles to one another. On the west limb a dyke of porphyritic basalt cuts through the rhyolite on the Rita 10 fraction and merges with the main body of porphyritic basalt lava as if the dyke were a feeder to the flow, and, accordingly, indicating that the tops face east. The dip of the contact between the porphyritic basalt and underlying rhyolite on the west limb of the fold is unknown. Along the north limb on the Rita No. 4 claim and on the axis of the fold on the east boundary of the Rita No. 6 claim the rhyolitic lavas dip beneath the porphyritic andesite at angles of 20 to 30 degrees. Little is known about the structure elsewhere in the wedge-shaped area.

As a result of this incomplete knowledge of the structure, a difficulty arises in the interpretation of the structural relations between the rhyolitic rocks within the wedge-shaped area and the overlying sediments and lavas that extend easterly beneath Rice Lake and thence northeast to the edge of the map-area. Two interpretations are possible. One hypothesis, which seems the more probable of the two, is that the rhyolitic rocks between the broad syncline north of Gold Lake and the overlying sediments form an anticline, and that the rhyolite on the north limb of this anticline dips conformably beneath the sediments. For such a structure there is no direct evidence except that a narrow chert bed in rhyolite on the Rita No. 1 claim 800 feet from the porphyritic basalt on the nose of the broad syncline dips 25 degrees north and shows the presence of at least a minor anticline in the rhyolite between the chert bed and the nose of the syncline. Additional evidence may have been destroyed as a result of the intrusion into the rhyolite of a large body of "quartz-eye granite" and of a large body of meta-gabbro, meta-diorite, and quartz diorite. The body of meta-gabbro and associated phases has been injected along much of the contact between rhyolite and overlying sediments and lavas and obscures the contact relationships. However, if this anticline and the conformable relationship exist, then the porphyritic basalt, which does not appear on the north limb of the assumed anticline, must either pinch out before this limb is reached or must have been completely destroyed by the intrusive body of meta-gabbro and related rocks. It is possible that both the syncline and the assumed anticline could die out in a short distance toward the west and merge with the northerly dipping monoclinal structure somewhere toward the narrow, V-shaped end of the wedge.

The alternative explanation of the relations between the sediments and rhyolite is that the sediments overlie the rhyolite with a structural unconformity. The sediments carry pebbles and boulders of rhyolite and porphyritic andesite, which resemble the underlying formations and may have been derived from these formations. This suggests that the underlying rocks were being eroded while the sediments were being

deposited, but does not show the presence of a structural unconformity or even an important erosion interval. If the unconformity is present it is unnecessary to assume the existence of the above-mentioned anticline, and the porphyritic basalt need not be assumed to die out or to disappear in the meta-gabbro.

The rhyolite south of Rice Lake and around Independence Lake is overlain to the north by sediments and volcanics, which occur in alternating bands that trend about north 70 degrees west in the west part of the area but curve gently near the east end of the lake until they strike north 70 degrees east in the area northeast of the lake. Dips are northerly and vary from 40 to 75 degrees. Cooke¹ on the basis of variation of grain within flows concluded that the formations face south and are overturned. The writer could find no significant variation in the texture of the flows, and from the following evidences has concluded, in agreement with Wright,² that the tops of the flows and sediments face north. On the Rachel claim, several layers in thinly laminated, tuffaceous sediment vary gradually from coarse grained at the south side to very fine grained at the north side. This variation in grain seems to be especially well developed in tuffaceous sediments where each lamination might form as a result of a single explosion of volcanic fragments and ash, which would be sorted into coarse material on the bottom and fine on top whether the particles fell on land or in water. In the north part of the same claim a dyke of rhyolite cuts through arkosic sediments and appears to merge with a rhyolite flow to the north, suggesting that the material of the flow had been supplied through the dyke fracture in underlying sediments. On the Normandy No. 2 claim a bed of tuff is followed north by a pillowed basalt flow which, for 3 inches from the contact, holds small fragments of the tuff, as if the flow had picked up the fragments from the surface of the tuff. Two small outcrops in the central part of the Gabrielle claim show basalt passing to the north into a 10- or 15-foot band of basaltic breccia, which is probably the brecciated top of the flow; the brecciated basalt is in sharp contact to the north with porphyritic andesite, which is fragmental in part. The north edge of a wide body of porphyritic andesite north of Rice Lake, as described in the chapter on General Geology, is commonly irregular in detail as if it were the fragmental surface of a lava flow, and a band of trachyte breccia to the north carries, for distances of 1 foot to 10 feet from the contact, many angular and lenticular fragments of porphyritic andesite like the rock of the main body of porphyritic andesite, as if picked up from the surface of this flow (See Plate II B). This relationship is seen wherever the contact is exposed for 3 miles along the north edge of the main body, and for a shorter distance along the south edge of a long, narrow lens of trachyte breccia which separates two flows within the main body. This contrasts with the southern or bottom contacts of the porphyritic andesite, which are generally straight and sharp, and the underlying fragmental rocks do not hold fragments derived from the porphyritic andesite.

¹ Cooke, H. C.: Geology and Mineral Resources of Rice Lake and Oiseau River Area, Manitoba; Geol. Surv., Canada, Sum. Rept. 1921, pt. C, pp. 6-7.
² Wright, J. F.: Rice Lake Map-Area, Southeastern Manitoba; Geol. Surv., Canada, Sum. Rept. 1922, pt. C, p. 61.

FOLDING OF THE SAN ANTONIO FORMATION

Feldspathic quartzites of the San Antonio formation, as exposed in a large area west and southwest of Rice Lake, have been folded into a broad syncline with a gently dipping south limb and a generally overturned north limb. The axis of the fold lies just north of Gold Creek and strikes about north 75 degrees west. Beds on the south limb commonly strike parallel to the axis, and usually dip from 20 to 40 degrees north. To the east, as the northerly trending contact with rocks of the Rice Lake series is approached, the beds swing sharply northeast and then northerly about parallel to the contact and stand vertically or dip away from it with tops facing west. At one locality near the contact the beds strike northwest and are overturned with dips of 80 degrees to the northeast; this unusual attitude is probably due to dragging of the beds up and to the southwest.

Along the axis of the main fold the beds swing sharply from east to northwest and continue with a fairly uniform strike of north 30 degrees west on the north limb. At a few places on the north limb the beds dip from 50 to 65 degrees southwest or are vertical, but generally they are overturned so as to dip from 80 degrees to 45 degrees to the northeast. At one locality a few beds on the north limb face northeast, as if forming part of a large drag-fold.

In these sediments the determination of tops at many localities is a simple matter because of an abundance of crossbedding. Accurate measurements of the strike cannot often be made because well-bedded material composed of alternating layers of coarse- and fine-grained material is uncommon. At any one locality, however, the average strike and dip of the cross beds gives the approximate attitude of the formations.

REGIONAL SCHISTOSITY

Each rock type of the Rice Lake series varies from massive at some localities to schistose at others. Massive structure predominates over large areas where gentle, open folds occur, as in rhyolite east of Rice Lake and in porphyritic basalt around Gold Lake. Elsewhere, secondary cleavage has generally been developed over wide areas, but some massive phases remain even where the rocks have been steeply tilted. North of Rice Lake, schistosity is better developed in bands of trachyte breccia and sediment than in more competent layers of porphyritic andesite and diabase. Schistose structure is especially well developed on a high ridge just southeast of Normandy Creek where basaltic lava and nearby gabbro and quartz diorite are greatly sheared across a width of 500 feet or more. Likewise, much of the rock for 1,000 feet from the south shore of Rice Lake is more highly schistose than is usual in the area. The cleavage in the rocks of the Rice Lake series generally strikes about parallel to the bedding, and everywhere dips northerly or vertically. The angle of dip varies from the vertical to as low as 40 degrees, but commonly is from 50 to 75 degrees. On the high ridge southeast of Normandy Creek, dips are steeper than usual, many being 80 degrees and vertical. North of Rice Lake the cleavage dips at about the same

angle as the bedding; south of the lake, where beds have a more gentle dip, the cleavage is steeper than the bedding. The schistose structure probably formed during the period of folding and was a result of the folding.

In massive phases, fragments in volcanic breccia are sharply angular and pebbles and boulders in conglomerate are rounded. In the schistose phases the sharp corners have been worn off the fragments and the fragments, pebbles and boulders, have been squeezed into lens-shaped bodies lying with their long axes parallel to the cleavage. Pillows which were originally only slightly longer than broad have, in highly schistose basalt, been much compressed parallel to the cleavage.

Of the rocks that intrude the Rice Lake series, the porphyritic andesite, gabbro, diabase, and porphyry dykes of the west group are generally more or less schistose, but are massive in places. Some of the more massive porphyry dykes cut across highly schistose structure of the lavas, as if the dykes were injected after the development of cleavage in the lavas. The several bodies of "quartz-eye granite," the large body of granitic rock at the east end of the area, and the porphyry dykes of the east group are in most cases massive.

The sediments of the San Antonio formation are generally fairly schistose and, in places, the secondary cleavage is well developed. The cleavage strikes easterly, parallel to the axis of the fold, and accordingly trends at an angle to the bedding at many localities. The cleavage dips north at angles varying from 30 to 55 degrees. Pebbles of quartz, rhyolite, and granite have retained their well-rounded character wherever seen in the slightly schistose rock. Crossbedding, however, has been considerably deformed at many localities. This is especially noticeable where the cleavage strikes at large angles to the bedding; at such localities the rock has been so much drawn out and sheared in a direction parallel to the cleavage that the crossbedding lines, which normally are nearly straight and meet overlying beds at angles of only 20 degrees or so, are sharply curved and meet overlying beds at large angles, as seen in sections about normal to the general dip. This process has reached an advanced stage on part of the large drag-fold 2,000 feet southwest of the outlet of Rice Lake. At this locality the cleavage strikes at right angles to the cross beds; the lines at the base of each cross bed curve sharply from a direction parallel to the bedding to a direction parallel to the cleavage, and continue as long dark lines along the cleavage planes until at the top of the bed they are cut at right angles by sharply curved basal bedding lines of the next overlying bed. Nearby, similar lines lie along the direction of cleavage, but the short, sharply curved, basal parts have apparently been destroyed; such lines may easily be mistaken for bedding although lying at right angles to it.

FRACTURE, SHEAR, AND FAULT ZONES

Zones of shearing, fracturing, and faulting are widely distributed in the area, and occur in all types of rocks. They are not numerous in sediments of the San Antonio formation or in large intrusive bodies cutting the rocks of the Rice Lake series, but are abundantly developed

in the rocks of the Rice Lake series and in small intrusives cutting these rocks. Where bands of rocks of various degrees of competency alternate with one another, as in the country north of Rice Lake, the more massive and competent layers yielded along narrow zones of fracture and shear, whereas the incompetent layers yielded throughout and a general schistosity was developed. At this locality a sill of diabase was especially susceptible to the formation of shear and fracture zones, and these zones rarely extend beyond its edges into bordering incompetent sediments.

The shear zones generally show displacement of one wall with respect to the other, and are faults. These shear and fault zones vary from 200 feet or less to 4,300 feet or more long and are up to 50 feet wide, but are commonly less than 10 feet wide. The rock has been rendered schistose across these widths and, in places, the schist is highly crenulated and drag-folded. Branch shears are locally developed and these extend outwards at small or large angles from the main shear. Most of them die out at short distances from the main zone, but some are linked with nearby shears. *En échelon* structure is uncommon. The direction and amount of movement along the faults is unknown, but the apparent horizontal displacement of contacts and of numerous dykes has generally been determined. Drag-folds are usually pulled in the direction of apparent horizontal displacement, but in a few zones they are dragged in the opposite direction. The apparent horizontal movement has generally been less than 100 feet, but a dyke has been displaced 1,500 feet along one fault.

The fracture zones are much less numerous than the shears and consist of tabular zones of irregular fracturing and brecciation without evidence of shearing or movement of one wall with respect to the other. These zones are up to 700 feet long and 40 feet wide, but are commonly less than 10 feet in width. A few zones are intermediate in character between the two types and consist of both sheared and brecciated material.

A few of the zones lie in the direction of bedding planes of enclosing rocks and are longitudinal zones; most of them cross the bedding and regional cleavage at various angles and are transverse zones. The zones strike in many directions when considered in the aggregate over the whole area (See Figure 2). At any one locality, however, they commonly trend in two directions at large angles to one another and may be divided into two rather distinct sets, namely, a northwest set including those that strike in the northwest quadrant, and a northeast set including those that strike in the northeast quadrant. With few exceptions the northwest zones dip vertically or steeply northeast and the northeast zones dip steeply northwest. Shear zones are abundantly developed in both sets; fracture zones are confined almost entirely to the northwest set. The two sets are exceptionally well developed in the northerly dipping diabase sill that lies along part of the north shore of Rice Lake and continues easterly beneath the lake (See Figure 4). The two sets can also be seen in the rocks north of this sill, in lavas south and east of Rice Lake, and in the large body of granitic rock east of Gold Lake. Almost all the numerous zones developed southeast of Rice Lake strike in the northwest quadrant and, although some trend at wide angles to others, all, with the exception of a northeast fault along which a rhyolite dyke has been injected on the Fox claim (lot 356), may be grouped in the northwest set.

The northerly facing angle between the two sets is somewhat greater than a right angle, and a line bisecting this angle tends to lie roughly normal to the bedding planes and to the regional schistosity. As a general rule, the apparent horizontal displacement along northwest faults has been to the right, that is, in following along a dyke or contact it is necessary to turn to the right to find the continuation beyond the fault; the displacement along northeast faults has generally been to the left. Two sets of fractures about at right angles to one another might be expected, from theoretical considerations, to form as the result of a single compressive or shearing force, and have been so produced experimentally.¹ It seems probable, therefore, that the two sets in Rice Lake area were so formed and are complementary to one another. The attitude of the two sets and the displacements along them indicate a general lengthening of the formations in the direction of their strike, and that the direction of compression was about normal to the strike, and in a general north-south direction. The total lengthening has not been great, for the fault displacements are usually small. Southeast of Rice Lake, however, where the faults are almost all of the northwest type, the displacement has been almost entirely to the right, that is the northeast side moved southeast with respect to the other side. At this locality three major faults have displaced a dyke a total distance of one-half mile.

It might be expected that tension cracks would form normal to the direction of elongation, that is, in a direction roughly normal to the beds. As may be seen on the accompanying maps, the west group of porphyry dykes tend to cross the bedding at large angles, swinging from northeast in the area south of Rice Lake, where the structure is south-easterly, to north in the region east and northeast of the lake, where the structure trends nearly east. The dykes may, therefore, have followed tension cracks which formed as a result of the same compression that caused the shear and fracture zones. As is to be expected, there has been no apparent movement or shearing along these tension cracks. Most of the dykes are faulted, indicating that the tension cracks developed somewhat earlier than the shear and fault zones. Notable exceptions to the above described general relation of the dykes to the structure, are a few porphyry dykes that followed the regional structure or schistosity and a few that followed faults of the northeast set.

Although the two sets of fracture and shear zones appear to be complementary, all did not form at exactly the same time. Those of either set may end against or be offset by shears of the other set and there has been considerable overlapping in time in their development. At one locality there seems to be a considerable difference in age, for one zone is apparently crossed by a dyke of diabase whereas other shears offset this dyke. Southeast of Rice Lake there has been more than one period of movement along some of the shears. This is shown by the fact that some porphyry dykes bend sharply on meeting a shear, follow along it for a short distance, and are themselves sheared by later movement along the fault zone. Along one of the shear zones a dyke of diabase has been displaced 1,500 feet whereas a porphyry dyke nearby has been

¹ Leith, C. K.: Structural Geology; Revised Edition 1923, pp. 24-46.

offset only 100 feet, indicating that one movement occurred after the intrusion of the diabase but before the porphyry had been injected and that another movement occurred after the porphyry had been invaded. Additional evidence of two movements is suggested by the fact that highly crenulated and drag-folded schist, which resulted from one movement, is crossed by closely spaced fractures lying parallel to the direction of shear and formed by later movement. Apparently the porphyry dykes were intruded during the period of structural adjustment, most of them coming in along the early, presumably tension, cracks. Vein quartz occurs along most of the fault and shear zones, as described in the chapter on Economic Geology, and the quartz also was introduced during the period of movement although at a late stage.

CHAPTER IV
ECONOMIC GEOLOGY
GENERAL STATEMENT

Many gold-bearing quartz veins have been found in the area, but up to the present time almost the entire production has come from one mine, the San Antonio. At this mine ore has been developed to a depth of 1,500 feet without any noticeable change in type, and it may continue to greater depths if structural conditions at depth are favourable. Good assays have been obtained from several other deposits in the area and small amounts of gold have been produced from a few.

Almost all the deposits may be classified as veins if the term is defined as including composite bodies composed of lenses and stringers as well as simple tabular bodies of vein material. A few deposits are mineralized dykes, apparently of no economic importance.

VEINS

DISTRIBUTION AND RELATIONS TO COUNTRY ROCK

Veins occur in many of the zones of fracturing, shearing, and faulting that have been described in the chapter on Structural Geology. The veins, like these structural zones, occur in essentially all rocks of the area, but are found mostly in diabase, porphyritic andesite, and rhyolitic lavas. Where bands of rocks of various degrees of competency alternate with one another, as in the country north of Rice Lake, the more massive and competent layers, like sills of diabase and bands of porphyritic andesite, yielded along fracture and shear zones to a greater degree than did the schistose, incompetent layers, such as trachyte breccia and sediment. Veins are, accordingly, more plentiful and better developed in the competent, more brittle layers.

This relationship is especially well shown along and near the north shore of Rice Lake where almost all the veins in the San Antonio and Forty Four mines lie in a sill of diabase (See Figure 4). The veins rarely extend beyond the edges of the diabase into the incompetent schistose sediments on either side. In fact, the veins generally die out in the diabase before the contacts are reached because the shear or fracture zones in which the veins have been deposited become very weak or die out as the contacts are approached. Ore-bodies are generally shorter than the veins, as if the fractures and shears became less tightly compressed away from the contacts and thus enabled freer access of vein material. In fact, almost all the ore has come from the widest section of this sill.

It has long been felt that diabase has had an especially favourable influence on the deposition of ore-bodies in Rice Lake area. This idea originated when an exceedingly rich but small ore shoot was found at a

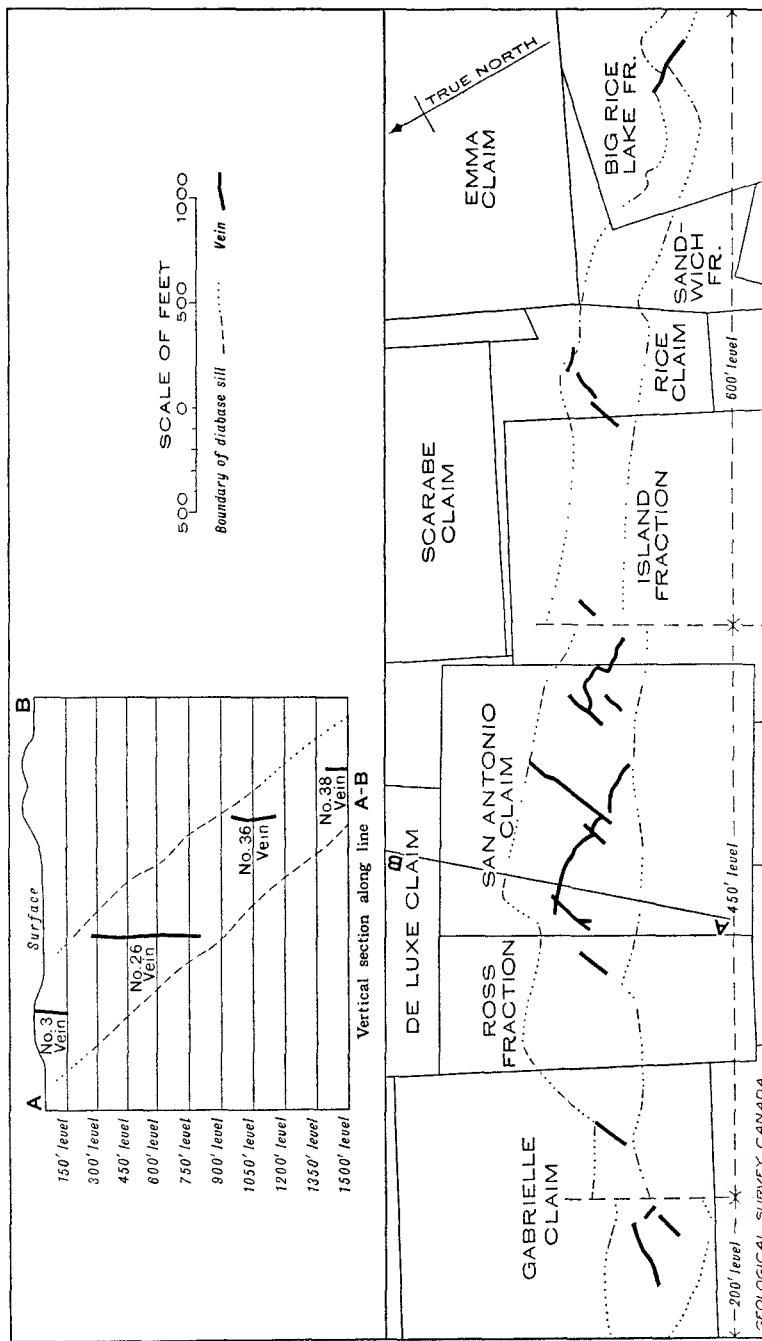


Figure 4. Plan and section showing veins in diabase sill at San Antonio and Forty Four mines.

locality where a vein crosses a narrow dyke of diabase on the Gold Pan claim, not far southeast of the area covered in the present report. Structural rather than chemical factors have been given as the reason for the localization of the gold, whether the dyke acted as a dam, as concluded by Cooke,¹ or was a favourable host rock, because of its brittle character resulting in fractures favourable to the deposition of gold, as thought by Wright.² Southeast of Rice Lake, and within the area covered in this report, several shear zones cross a narrow dyke of diabase, but values are not known to be higher at the intersections than elsewhere. One of these zones, however, is without vein material except at the intersection of the dyke, where quartz has been deposited, suggesting a favourable influence of the dyke rock in the precipitation of vein quartz. Such narrow dykes, however, appear to be less favourable to the formation of ore than wide bodies of diabase such as at the San Antonio mine.

However, search for ore deposits should not be confined to bodies of diabase, for concentrations of gold are known to occur in other rocks. A broad, easterly trending, competent layer of porphyritic andesite north of Rice Lake fractured in much the same way as the sill of diabase. Although fracture and shear zones are apparently not as well developed in this rock as in the diabase, some ore has been located in the porphyritic andesite, as in No. 34 vein on the Gabrielle claim, owned by San Antonio Gold Mines, Limited, and in No. 1 and No. 2 veins on the property of Wingold Mines, Limited. A pocket of rich ore is said to have been found in a vein on the Chicamon claim, also in porphyritic andesite. Rhyolite is the host rock of an apparently shallow body containing good values in No. 1 zone on the Ranger claim. In No. 1 zone, or the Independence vein, on the Rita No. 1 claim, a small ore shoot lies in rhyolite on the foot-wall side of a dyke of porphyritic andesite and extends into the under side of the dyke itself, as if the dyke rock acted as a dam to the gold-bearing solutions. The narrow body of gabbro, which presumably extends easterly beneath Rice Lake, resembles the diabase and is about the same width as parts of the diabase sill in which the San Antonio veins occur. It presumably would act as a competent layer favourable to the development of fracture and shear zones; where penetrated by diamond drills at two localities, however, no encouraging assays were obtained.

GENERAL CHARACTER

The veins, like the shear and fracture zones which they occupy, strike in all directions when considered in the aggregate, but at any one locality they commonly trend in two directions at large angles to one another and, accordingly, may be divided into two sets, a northwest set and a northeast set. A few of the veins lie parallel to the bedding of enclosing rocks and are longitudinal veins, but by far the larger number trend at considerable angles to the regional structure and schistosity and are transverse veins. The northwest veins commonly dip from vertical to steeply northeast, but a few dip southwest; the northeast veins in most cases

¹ Cooke, H. C.: Geology and Mineral Resources of Rice Lake and Oiseau River Areas, Manitoba; Geol. Surv., Canada, Sum. Rept. 1921, pt. C, p. 33.

² Wright, J. F.: Rice Lake Map-Area, Southeastern Manitoba; Geol. Surv., Canada, Sum. Rept. 1922, pt. C, p. 71.

dip vertically or northwest, but a few dip southeast. As already stated, the two sets of openings appear to be complementary, but all did not develop at one time for they end one against another, or offset one another. Vein material was apparently introduced over a considerable period of time during the process of fracturing and shearing, with the result that vein quartz may swing from one set to another even if the openings formed at different times, or quartz in a vein of one set may cut across quartz of another. In the San Antonio mine it appears that the earlier-formed veins are better mineralized and carry most of the gold, and that later veins are mostly of barren quartz deposited along faults cutting the mineralized deposits.

Most of the deposits lie along shear and fault zones, but a few of both sets lie in zones of irregular fracturing and brecciation, along which there has been no apparent displacement of one wall with respect to the other. The internal structure of the deposits depends very largely on the character of the shear or fracture zone in which they lie. Thus, in irregular fracture zones which show no evidence of shearing or fault movement, numerous intersecting stringers of vein material may branch and ramify in all directions, following cracks between broken blocks of country rock (See Plate I), or a fairly definite but crooked vein may follow along the middle of the zone and be accompanied by many stringers that branch outward from the main vein; the branch stringers strike at many angles, but usually trend either northeast parallel to the northeast set of veins or easterly along cleavage planes of the regional schistosity. This type of deposit is well represented in the northwest veins in the San Antonio mine, where one such vein has a maximum length of 700 feet, dies out at a depth of about 800 feet on approaching the contact of the inhospitable sedimentary formation, and has been stoped across widths up to 40 feet, with an average of about 9 feet. Of a somewhat similar type, structurally, is a northeast vein on the O.K. No. 9 claim, where quartzite has been fractured along an irregular zone without marked shearing, and vein quartz forms a network of intersecting stringers along the zone.

On the other hand, the vein material along shear and fault zones, whether they strike northwest or northeast, generally forms elongated bodies lying parallel to the cleavage of the enclosing shear zone. In some of these deposits, as in the northeast veins of the San Antonio mine, a rather definite quartz vein, generally varying from 1 to 3 feet wide, follows along the middle of the zone and is accompanied on both sides by stringers of quartz lying parallel to the main vein and to the cleavage of the shear zone. One of these veins is about 600 feet long, has been followed to a depth of 1,500 feet, and has averaged about 4 feet in stoping width. The quartz of these veins and of a vein on the Fox claim (lot 356) presents a banded structure which parallels the walls of the veins and is due chiefly to the presence of streaks of pyrite and long shreds and bands of schist. A more common type of vein along shear zones, none of which has been mined, is well developed east and southeast of Rice Lake, and consists of quartz lenses irregularly distributed along and across the zones and accompanied by small, parallel, quartz stringers. Most of the lenses are less than 1 foot wide, but some are 2 or 3 feet wide and from 10 to 100 feet long. One large lens is 50 feet long and up to 15 feet thick. The shear zones are commonly less than 10 feet wide and the quartz lenses and

stringers may be distributed across a part, or the whole width, of the zone, but vein material generally constitutes considerably less than half, and schist more than half, of the material at any one locality. Quartz is not usually distributed along the full length of the shear zones, which vary from 200 feet or less to 4,300 feet or more long, but occurs sporadically, and some shears are without vein material for hundreds of feet along their strike. As a general rule, wide shear zones of large displacement carry only small amounts of vein material.

A few deposits are intermediate in character between the branching stringers and veins in fracture zones and the veins lying in shear zones, that is, they lie in zones of both shearing and irregular fracturing. For example, several northeast veins in the San Antonio mine exhibit, in part, an irregular network of intersecting stringers as well as the more typical, parallel vein structure. The northwesterly striking Chicamon vein and the northeasterly striking Independence vein, located southeast and east of Rice Lake, respectively, are composed partly of parallel lenses and stringers and partly of irregular stringers in brecciated rock.

MINERALIZATION

The northeasterly and northwesterly sets of veins are similar in type of mineralization, and both consist chiefly of quartz. Carbonate is commonly present as scattered patches in the quartz and, in places, forms veinlets cutting the quartz and wall-rock; the carbonate generally weathers rusty brown or buff coloured, indicating a content of iron, and is probably ankerite; small amounts of white and pink calcite also occur. Fine-grained, massive chlorite is also a common vein material and forms irregular patches and veinlets in the quartz. Red and white albite is also rather widely distributed in the quartz, but occurs in small amounts. Orthoclase is rare. Very finely crystalline black tourmaline occurs as small aggregates in quartz and as crenulated lines crossing quartz and carbonate.

Pyrite is the common sulphide and is plentiful in some veins, but as a rule sulphides are rare, and in some veins are entirely lacking. The pyrite occurs in the quartz as disseminated grains and cubes, as small, irregular-shaped masses, and as long streaks of very fine-grained material. Chalcopyrite is found as blebs and veinlets at a few localities. Sphalerite and galena are locally present in small amounts. Native gold is widely distributed in small quantities in the veins, and at a few localities is concentrated in small pockets and ore-bodies. In the San Antonio mine gold is occasionally seen in quartz and in pyrite, but commonly is invisible to the naked eye and is closely associated with streaks and patches of finely crystalline pyrite.

WALL-ROCK ALTERATION

Wall-rock along many of the veins shows little or no evidence of alteration except for the common development of chloritic and sericitic schists along the shear zones. Along some veins, however, the rock is pyritized, or is altered to various mixtures of pyrite with carbonate, albite, sericite, and chlorite. Generally the wall-rock carries little or no gold, although the altered material may be mined for the gold contained in veinlets cutting the rock. Alteration is more pronounced along northwest veins than along northeast veins.

Wall-rock alteration is unusually well developed in diabase along northwest fracture zones in the San Antonio mine. There the normal dark green diabase is altered to a grey rock for distances of several inches outwards from the main veins and from the many associated branch stringers. Where intersecting stringers are closely spaced large bodies of rock are chiefly of the altered material. The altered rock consists of albite, carbonate, pyrite, sericite, and chlorite. Albite is confined chiefly to the immediate vicinity of the veinlets, and as it disappears outwards remnants of chlorite appear and this mineral increases in quantity as the altered rock passes gradually into the normal diabase in which chlorite is an abundant constituent. The pyrite and carbonate are more widely distributed than the albite, and the pyrite occurs chiefly as disseminated cubes, which increase in numbers toward the veinlets and are most plentiful in the albitized phase. Pyrite also forms a few veinlets cutting the altered rock. Epidote is plentiful in the normal diabase, but is lacking in the altered rock. Grains of quartz and leucoxene, which are characteristic minor constituents of the normal diabase, remain even in the most highly altered phase.

Along northwest veins in porphyritic andesite north of Rice Lake the andesite, in places, is altered to a mixture of carbonate, sericite, and pyrite, which at some localities is accompanied by abundant albite. At other localities, along northwest veins, wall-rock of rhyolite, quartzite, and granite carry disseminated grains of pyrite.

Along northeast veins, alteration is not generally noticeable, although in some places the wall-rock schist carries cubes of pyrite. Along northeast veins in the San Antonio mine epidotized diabase is altered to chlorite-sericite schist carrying cubes of pyrite, and in some places is slightly gone to a mixture of albite and carbonate.

The best ore-bodies have been found in veins showing abundant wall-rock alteration to albite, carbonate, and pyrite, much ore has been mined from veins showing only pyritized wall-rock, and either no ore or only small pockets of ore have been found in veins with little or no wall-rock alteration. However, some veins contain no ore, although their wall-rocks are altered in the same manner as the rocks adjacent to ore deposits. Thus, although there appears to be a very general relationship between wall-rock alteration and ore deposition, the degree of alteration does not always indicate the presence or absence of ore.

MINERALIZED DYKES

Although many dykes in the area carry a few disseminated grains of pyrite, only a few carry this mineral in sufficient quantity to attract attention. Such dykes are generally of fine-grained, pink to grey, rhyolitic material, although a few are of quartz-feldspar porphyry. The mineralized dykes vary from 10 to 40 feet wide and are commonly cut by irregular stringers of quartz carrying pyrite and, at one locality, chalcopyrite. A few irregular, dyke-like bodies of soda-rich, rhyolitic rock are thoroughly permeated with irregular blebs, lenses, and stringers of quartz mixed with carbonate and black tourmaline. The dykes do not appear to be of economic importance, although some gold has been found in them.

Of similar character are lenses and irregular bodies of rhyolite and quartz porphyry that have been injected here and there along a few shear

zones into which vein quartz has also been introduced. The injected rocks carry scattered grains of pyrite and are cut by veinlets of quartz and carbonate.

ORIGIN OF THE VEINS

Gold-bearing veins occur in essentially all rocks of the area, including those of the Rice Lake series, the intrusive bodies cutting these rocks, and the sediments of the San Antonio formation. Veins within a large body of granitic rock at the east end of the area may have originated in this granite. Veins in the San Antonio sediments can not be linked with any intrusive rocks, as no rocks of this class have been found to invade this formation within the map-area.

The great majority of the veins lie in rocks of the Rice Lake series or in small intrusives cutting these rocks. Most of the veins occur in the vicinity of Rice and Independence Lakes. The porphyry dykes of the west group, as described in the chapter on General Geology, also occur in this area, and a close relationship between the dykes and the veins is suggested by the following observations. Soda-rich feldspar is a characteristic and abundant constituent of the dykes and also occurs in many of the veins and in the adjacent wall-rocks. Dykes that are thoroughly permeated with abundant vein quartz do not differ greatly from veins holding abundant feldspar. Pyrite is a common constituent of the veins and occurs as disseminated grains in some of the dykes. The porphyry dykes and veins both appear to have formed during the period of structural adjustment and to be of the same general age, although the dykes are somewhat older than the veins. Thus, as described in the chapter on Structural Geology, presumable tension cracks and the two sets of shear and fracture zones appear to have developed from the same causal stresses, the tension cracks forming before the shears; the porphyry dykes were injected mostly along the tension cracks before the shears were developed, but a few were intruded along the shears; the veins, as explained above, were introduced during the process of fracturing and shearing.

The porphyry dykes of the west group, as stated in the chapter on General Geology, were probably derived from a granitic body somewhere south of the map-area, and it seems probable that the veins also originated in this granite. Small bodies of granite do occur just southeast of Red Rice Lake and one-half mile south of the map-area, but their relationship to the dykes has not been studied closely. One of these small granite bodies resembles in general appearance the "quartz-eye granite" of Elbow-Morton area¹ and elsewhere in northern Manitoba where there is evidence to suggest a genetic relationship between "quartz-eye granite" and gold-bearing quartz veins.

In the limited area studied by the writer a tendency for vein material to increase toward granite bodies was not observed, but this was found to be true for the larger area investigated by Cooke.² He also found a variation in composition of the vein material with increasing distance from the granite, and concluded that the vein material originated in the granite.

¹ Geol. Surv., Canada, Mem. 186, pp. 5-7, 13 (1935).

² Cooke, H. C.: Geology and Mineral Resources of Rice Lake and Oiseau River Areas, Manitoba; Geol. Surv., Canada, Sum. Rept. 1921, pt. C, p. 29.

CHAPTER V
DESCRIPTIONS OF PROPERTIES
BISSETT GOLD MINES, LIMITED

This company was incorporated in 1936 to explore a block of forty-four claims lying west and northwest of the property of San Antonio Gold Mines, Limited. The company's office is at 941 Somerset Building, Winnipeg, Manitoba. The claims include the Key fraction, High Ridge, High Ridge 1, Augustina, Ritz 5, Reo 2 and 3, Reo 3 fraction, Contact 3 fraction, Rose, Sax 5 to 13, Patsy, Gold Plants 5 and 6, and other claims north and west of Map 465A. Some trenching has been done on deposits on the Sax No. 7 and No. 10 claims, and during the summer of 1936 a program of diamond drilling was completed on the High Ridge claim and on the adjoining Augustina claim and Key fraction.

The area drilled on these three claims is almost completely covered by clay and swamp. A series of eight short holes were first put down to intersect the favourable diabase formation that had previously been traced to within 600 feet of the property by drilling on the Cartwright claim, held by San Antonio Gold Mines, Limited. The diabase was found to dip about 55 degrees northeasterly, to be only a little over 100 feet thick, and to pinch out after extending for about 800 feet into the property. No important veins were intersected.

Twelve holes were then put down beneath drift on the Key fraction and High Ridge claim north of the diabase sill. A few of these holes cut the diabase at greater depth, and several of them intersected vein quartz in sheared porphyritic andesite. The quartz and nearby rock carried disseminated grains of pyrite and some gold. Several sections of vein material were intersected and could not be definitely correlated from one hole to the next. They apparently, however, constitute a broad zone of mixed quartz and rock. This zone, called No. 1 zone, is located approximately as shown at locality 3, Map 465A.

On Sax No. 7 claim seven prospect pits have been dug along a zone of quartz stringers, called No. 2 zone (locality 2, Map 465A). The stringers occur in a dyke of porphyritic andesite which cuts fragmental volcanic rocks. The dyke varies from 10 to 15 feet wide and is exposed here and there for 500 feet along the strike of north 85 degrees east. In most of the pits the dyke is cut across its full width by a network of many irregular stringers of quartz, which carries abundant red albite and smaller amounts of chlorite, buff-weathering carbonate, and black tourmaline. The dyke passes beneath drift at both ends, and at a point 100 feet west of the most westerly outcrop has been intersected in a diamond drill hole.

Along the south edge of an outcrop on the south boundary of Sax No. 10 claim a similar dyke, possibly the westerly extension of the same

dyke, outcrops for a length of about 200 feet, is cut by many quartz stringers, and has been opened up in four prospect pits. This is called No. 3 zone (locality 1, Map 465A).

SAN ANTONIO GOLD MINES, LIMITED

References: "The San Antonio Mine and Mill," by The Staff; Trans. Can. Inst. Min. and Met., 1936, pp. 1-9.

"The San Antonio Gold Mine," by J. A. Reid and D. J. Kennedy; Can. Min. and Met. Bull., 1933, pp. 405-505.

"The Geology of the San Antonio Gold Mine, Rice Lake, Manitoba," by J. A. Reid; Ec. Geol., vol. 26, 1931, pp. 644-661.

"Geology and Mineral Deposits of a Part of Southeastern Manitoba," by J. F. Wright; Geol. Surv., Canada, Mem. 169, pp. 80-86 (1932).

"Annual Reports," San Antonio Gold Mines, Limited.

"Annual Reports on Mines and Minerals"; Manitoba Dept. of Mines and Natural Resources, Mines Branch, 1928-1934.

HISTORY AND DEVELOPMENT

The property of San Antonio Gold Mines, Limited, is located along and near the north shore of Rice Lake close to the west end (See Plate III B). The head office is at 237 Curry Building, Winnipeg, Manitoba. J. D. Perrin is president, D. J. Kennedy is mine manager, and G. L. DeHuff is mine geologist. Underground work has been confined chiefly to the Gabrielle and San Antonio claims and almost the entire production has come from the San Antonio claim, where workings have proceeded to a depth of 1,500 feet. Intensive exploration work was not commenced until 15 years after the discovery of gold on the property, and it was not until 3 years of persistent underground development had been completed that ore was found in quantities sufficient to warrant the erection of a mill. Today, exclusive of base metal mines, it is the largest gold producer in Manitoba and has the distinction of being the first dividend-paying gold mine in the province.

The San Antonio claim was staked on May 17, 1911, by Alexander Desautels. Only a small amount of work was done on the property prior to 1926, at which time this claim and the adjoining Island fraction and Ross fraction were acquired by the Wanipigow Syndicate. Under the direction of J. D. Perrin, further surface work and sampling was immediately undertaken on four veins that had been located on outcrops near the lake shore, and on a nearby island which, by means of waste rock from the mine, has since been connected with the mainland. Following an examination of the surface showings by J. A. Reid, a mining plant was installed and the sinking of No. 1 shaft was commenced at a locality about 70 feet south of No. 3 vein. The shaft had been sunk to 164 feet and about 1,000 feet of lateral work had been completed on the 150-foot level when the work in this section of the property was abandoned early in the summer of 1927. Operations were then started on No. 2 shaft, located on the island between No. 1 and No. 2 veins. On July 28, 1927, Wanipigow Mines, Limited, was incorporated to carry on with the development, and on September 16, 1927, the name of the company was changed to San Antonio Mines, Limited. By the summer of 1930 No. 2 shaft had

been sunk to a depth of 617 feet, with levels established at 125, 300, 450, and 600 feet; below the 600-foot level an inclined winze, known as No. 1 winze, was sunk to a little over 900 feet, with levels at 725 and 900 feet. During this period of extensive exploration two veins, known as No. 08 and No. 09 veins, were discovered underground and some ore was developed in each of them, but it was not until after No. 16 vein had been discovered in 1929 that it was decided to build a mill. At that time ore reserves were estimated at 61,000 tons, with an average value of \$13.35 across an average width of 5 feet.

From September 1, 1930, to April 15, 1932, little underground development was completed, although diamond drilling was carried on from the underground workings during the summer of 1931 with the object of locating the upward extensions of No. 08 and No. 16 veins. On the completion of arrangements for further financing the name of the company was changed, on July 31, 1931, to San Antonio Gold Mines, Limited. By construction of a transmission line to connect with a substation at the Central Manitoba mine 17 miles to the southeast, electric power was made available from Great Falls. The mill, with a rated capacity of 150 tons a day, commenced operation on May 1, 1932.

No. 26 vein was discovered in diamond drill intersections early in 1933, and by the end of the year development of this vein resulted in more than doubling the probable ore reserves. Due to the encouraging developments on this vein a new central shaft, called No. 3 shaft, was completed to a depth of 1,074 feet during 1934, and the capacity of the mill was increased to 225 tons a day. Further development work during the year indicated that No. 16 vein continued to the 1,050-foot level and that No. 26 vein died out on approaching a sedimentary contact between the 750- and 900-foot levels. During 1935 the mill was enlarged to a capacity of 325 tons a day. During the summer of 1936 a new vein, called No. 36 vein, was discovered on the 1,050-foot level. On February 14, 1937, a vertical winze, known as No. 2 winze, was commenced on the 1,050-foot level to permit exploration on three new levels, at 1,200, 1,350, and 1,500 feet. By the end of the year No. 36 vein had been developed on the 1,200-foot level, No. 16 vein had been found on each of the three levels, and a new vein, known as No. 38 vein, had been discovered at the 1,500-foot horizon. No. 16 and No. 26 veins have been the major ore producers, but some production has come from several of the many other veins that have been discovered in the underground workings.

Ore reserves were increased from 61,090 tons in 1931 to 225,000 tons in 1934, and were maintained at approximately the latter figure during 1935 and 1936 when ore was being mined at the rate of about 100,000 tons a year. Up to the end of 1936 the total amount received for bullion was \$3,878,362, values being chiefly in gold with some silver. The first dividend was paid in 1934 and the total disbursement to the end of 1936 was \$912,762.

In 1932 the company acquired the property of Scarab Mines, Limited, lying to the north and northeast of the San Antonio claim. This group includes the West Scarab, Annex, Deluxe, Scarab, and Emma claims and the Mite fraction. Some surface work was done on the claims in 1914

by Scarab Developments Company, Limited. In 1927 the property was acquired by Scarab Mines, Limited, who continued the surface exploration. No veins of economic importance were located although the ore-bodies on the San Antonio claim are expected to continue in depth onto this group of claims.

In 1935 San Antonio Gold Mines, Limited, purchased from Gabrielle Mines, Limited, the Gabrielle and Cartwright claims and part of the Gabrielle fraction, which lie to the west of the original holdings. Prior to the acquisition of this property underground exploration had been undertaken on two levels on the Gabrielle claim and a considerable amount of diamond drilling had been completed on the Gabrielle and Cartwright claims.

The Gabrielle claim was staked on March 6, 1911, by Captain E. A. Pelletier, following a discovery of gold on the property by Duncan Trueheart. Gabrielle Gold Mines, Limited, was soon formed to develop the property. From 1911 to 1914 this company did surface work, sunk a prospect shaft, and did a small amount of drifting on each of two deposits that had been discovered on the claim. A small stamp-mill was installed.

On August 19, 1919, the property was taken over by Gabrielle Mines, Limited. Little further work was done, however, until 1927 when interest was revived as a result of development work that was being done on the San Antonio claim. At various times between 1927 and 1933 a considerable amount of diamond drilling was done, and some interesting ore intersections were reported to have been found. In 1934 an electrically equipped mining plant was installed, a new shaft was sunk to a depth of 340 feet, and a considerable amount of development work was completed on two levels. The mine was closed down for a short period, until April 1935, when International Mining Corporation optioned the property. After about 4 months' operations officials of the corporation stated that results of their work had been inconclusive and the option was dropped. On October 10, 1935, the property of Gabrielle Mines, Limited, was sold to San Antonio Gold Mines, Limited. The 450-foot level on the San Antonio claim was then connected by a long crosscut and raise with the second level on the Gabrielle. One of the Gabrielle veins, originally known as No. 3 vein but now called No. 34 vein, was then tested by diamond drilling and was later explored by drifting on the 450-foot level.

GEOLOGY

Rocks exposed on the San Antonio, Gabrielle, and other claims of the group include tuffaceous sediments, arkose, lava flows, volcanic breccia, and intrusives. The sediments are mostly drift covered north of the lake, but are well exposed on Hares Island and on nearby small islands. On Hares Island the bedding strikes north 70 degrees west and dips from 40 to 65 degrees northerly. The sediments are overlain to the north by a thin flow of basaltic lava, showing pillow structure in places. This flow is overlain to the north by a thin layer of volcanic breccia which, in turn, is overlain by a thick body of coarse porphyritic andesite.

The sediments along and near the lake are invaded by a sill-like body of dark green to grey rock which may be termed meta-diabase or, simply, diabase. The body strikes about north 55 degrees west and has an average dip of 45 degrees northeasterly. It extends for a distance of 6,200 feet across the property where it is only 200 or 300 feet thick in some places, but widens to 500 feet on the San Antonio claim and to almost this thickness on the southwest part of the Gabrielle claim. The sediments adjacent to the contacts of the diabase are, in places, highly sheared to a sericite schist and are partly carbonatized and chloritized.

The diabase, as seen in the underground workings, is cut by a few small dykes of light grey rhyolitic rock and darker coloured, more basic material, and by a dyke of coarse feldspar porphyry carrying scattered albite phenocrysts up to three-eighths inch long. The porphyry dyke varies from 15 to 30 feet wide, strikes northwesterly, dips about 50 degrees northeast, and is exposed on both levels on the Gabrielle claim.

VEINS

Some thirty-four veins have been discovered on the property; ten of these are in the Gabrielle section and the remainder are in the San Antonio section of the mine. One vein lies in porphyritic andesite; all the others are within the diabase sill. Some of the latter veins have been found in the narrower parts of the sill, but most of them occur in wide sections on the San Antonio and Gabrielle claims. Almost the entire production has come from veins in the widest section of all, on the San Antonio claim. Apparently wide parts of the diabase are most favourable for the deposition of ore. In the San Antonio section the diabase maintains its thickness of approximately 500 feet to a depth of at least 1,050 feet, below which its contacts have not yet been determined. The veins, like those elsewhere in Rice Lake area, may be divided into two sets, a northwest set and a northeast set (See Figures 3 and 4). The veins of the two sets generally differ from one another in internal structure, in type of wall-rock alteration, and in other ways, although some veins are more or less intermediate in character between the two types.

NORTHWEST SET OF VEINS

The veins of the northwest set vary in strike from north 25 degrees west to north 65 degrees west and generally dip about vertically, although several of the deposits dip steeply northeast and parts of others dip southwest. They follow fracture zones which show no displacement of one wall with respect to the other and which are characterized by brecciation and a lack of shearing. The largest vein of this type, No. 26 vein, has a maximum length of about 700 feet, as measured horizontally, and extends from the surface to a vertical depth of about 800 feet, where it dies out; stoping widths have been as much as 40 feet and have averaged about 9 feet. This vein has been the largest ore producer in the mine. Other veins of the same general type include No. 36, No. 38, and the 709 intermediate vein.

The veins of this set generally strike at angles of only 20 or 30 degrees more northerly than the diabase and, because they die out above

and below on approaching the upper and lower edges of the northerly dipping host rock, they pitch gently northwest. The workings have progressed down the dip of the diabase and new veins of this type have been discovered successively, in depth and to the north near the upper contact, as the old ones have been found to die out near the lower contact (See section on A-B, Figure 4). As the contacts of the diabase are approached the veins die out in stringers and gold values drop. Some of the veins apparently end in a similar fashion, either up or down the pitch, as veins of the northeast set are approached; others meet these northeast veins, merge with them, and may either end or appear again in an offset position on the opposite side.

The northwest striking deposits have indefinite boundaries, are quite crooked, and have been found to pinch and swell along the strike and up the dip. Some of them are offset by many small faults which emphasize their crooked character.

The central part of each northwest vein commonly consists of a sinuous, vein-like body of quartz varying from 1 inch to several feet wide. In some veins such central parts are arranged *en échelon*. Numerous stringers of quartz branch from this central part or main vein and extend for several feet into the country rock. These commonly trend north-easterly at a large angle to the strike of the main vein and dip northwest; they are roughly parallel with the set of northeast veins, although it is fairly common to find that the stringers on one side of the lead strike at a different angle from those on the other side. At some localities, however, most of the stringers lie about parallel to the main vein, and at still other places they cross one another to form a network of intersecting veinlets (See Plate I). In some of the northwest veins the central core of quartz is lacking and the deposits consist entirely of irregular stringers filling cracks between broken blocks of diabase.

The normal dark green diabase is altered to a grey rock for distances of $\frac{1}{2}$ inch to 2 inches or more outwards from the main vein and from many of the associated stringers. Large patches of the grey alteration product occur where stringers are closely spaced. A few quartz stringers, however, are without associated altered rock and rare narrow bands of the altered material cross the normal diabase without associated vein quartz. On the 750-foot level, near the bottom of No. 26 vein, large bodies of grey alteration product occur without much vein quartz. Generally, the alteration is most pronounced adjacent or close to the veins, and this highly altered rock is light grey. It consists chiefly of albite mixed with considerable quantities of buff-weathering carbonate, probably ankerite, and with or without a groundmass of fine-grained sericitic material. This highly albitized and carbonatized rock passes outwards from the main quartz lead and branch stringers into a less altered, greenish grey or mottled green and grey rock composed almost entirely of a fine-grained, felty mass of sericite mixed with smaller amounts of carbonate and varying quantities of chlorite. Epidote and chlorite are abundant constituents in the normal diabase, but the epidote is lacking in all phases of the altered rock and chlorite remains only in the less altered phase. Grains of quartz and leucoxene, which are characteristic minor constituents of the normal diabase, remain even in the most highly

altered phase. Large and small cubes of pyrite are scattered throughout most of the normal and altered diabase across the full width of the drifts and stopes, but are most abundant in the light grey, most highly albitized phase. The altered wall-rock is also veined, in places, by streaks of finely crystalline pyrite.

The quartz of the main veins and of many of the branch stringers is mixed with considerable quantities of a buff-weathering carbonate, probably ankerite, and small amounts of calcite, albite, chlorite, and, rarely, orthoclase. The buff-weathering carbonate, albite, and chlorite commonly occur as irregular patches in the quartz; some of the quartz veinlets are bordered by narrow veins of carbonate; other stringers consist entirely of either albite or carbonate. Albite stringers were seen cutting the light grey, albitized diabase, and are in turn veined by quartz and carbonate. The central or main quartz veins and many of the branch veinlets are mineralized with pyrite, small amounts of chalcopyrite, and, rarely, with sphalerite and galena. The pyrite occurs as disseminated grains and cubes and as irregular patches and streaks of fine-grained material. Pyrite cubes are much less abundant than in the wall-rock, but the fine-grained pyrite is most plentiful in the quartz. Best values in gold are generally found in association with the fine pyrite. In places the gold is coarse enough to be seen with the unaided eye and occurs both in the fine pyrite and in the quartz. The wall-rock generally carries only insignificant amounts of gold, although large parts of it are mined because of the gold contained in the stringers of quartz and streaks of fine pyrite that cross it. Of later formation than the fine pyrite, and found cutting across streaks of this mineral, are horizontal gash veinlets of quartz and irregular stringers of either quartz or finely crystalline, massive chlorite. Some of the late quartz veinlets contain patches of chalcopyrite. A few crenulated streaks of very fine-grained black tourmaline have also been introduced at a late stage. These cut altered diabase and stringers of quartz and carbonate.

No. 1 and 02 Veins. No. 1 vein (locality 10, Map 464A) was found on an island in early years of surface exploration. No. 2 shaft was sunk at a point about 20 feet south of the outcrop, and what may be the downward extension of the deposit was explored on the 150- and 300-foot levels for lengths up to about 160 feet. On these levels the deposit is known as No. 02 vein (*See Figure 3*). Gold values are said to be generally low, although some ore has been stoped from above the 150-foot level. In the underground workings the vein strikes north 50 degrees west and dips about 70 degrees northeast. Quartz stringers in the deposit carry red albite and orthoclase.

No. 2 Vein (locality 9, Map 464A) outcrops about 70 feet southwest of No. 2 shaft. The vein is now largely covered; it is reported to strike northwest and to have been explored underground, but has not been found below the 150-foot level.

No. 3 Vein (Figure 4, and locality 7, Maps 464A and 465A) is now covered by the mine dump. In early years of surface exploration it was traced for some 300 feet along the strike of north 40 degrees west. The vein dips steeply southwest. No. 1 shaft was sunk at a point about

80 feet south of the deposit and the vein was explored on the 150-foot level. It is reported that values were low except in one section at the southeast end of the workings where the vein averaged \$16.55 over a width of 2·1 feet for a length of 31 feet.

No. 4 Vein (locality 8, Map 464A) was explored in prospect pits during early operations on the property. It strikes north 45 degrees west and dips vertically. The outcrop consists of a quartz vein varying from $\frac{1}{2}$ foot to 2 feet wide, with many associated quartz stringers, giving a total width of 10 feet or more of mixed quartz and diabase. The quartz carries patches and veinlets of red feldspar and of buff-weathering carbonate, and the diabase near the vein is spotted with cubes of pyrite. This vein now appears to be the outcrop of No. 26 vein, which was later discovered underground.

No. 709 Intermediate and No. 08 East Vein. The 709 intermediate vein was developed on the 600- and 725-foot levels during early operations. It made the first ore-body in the mine and was stoped across widths up to 25 feet. Much of the ore consisted of pyritized, altered wall-rock and stockwork. The vein follows a crooked course, striking about north 30 degrees west and dipping about vertically. It has been drifted on for 64 feet on the 600-foot level (See Figure 3) and for 184 feet on the 725-foot level.

In 1937 the upward continuation of the vein was developed on the 450-foot and 300-foot levels where it is called No. 08 east vein and, in part, No. 207 vein. This recent work is not shown on Figure 3, although a short section of the vein is indicated at its junction with No. 22 vein on the 300-foot level. On this level the vein has been traced from No. 22 vein northwesterly to the northeast end of the upper 08-09 vein, a distance of 460 feet as measured in a straight line. The vein is considerably longer than this, because it is very crooked, and ore is continuous for a length of 580 feet. On the 450-foot level the vein has been followed along a tortuous course for 450 feet southeasterly from its junction with the upper 08-09 vein and crosses the boundary line between the San Antonio claim and Island fraction (See Figure 4).

On the 300- and 450-foot levels the vein matter merges with that of the upper 08-09 vein, and on the 600- and 725-foot levels it dies out on approaching this northeast vein or its projected strike. Nowhere has it been found on the northwest side of this vein. Judging from present developments, therefore, the pitch of the northwest end of the vein appears to be determined approximately by the dip of the upper 08-09 vein, which is 65 degrees northwest. At the southeast end the vein matter merges with that of No. 22 vein on the 300-foot level and, elsewhere, appears to die out in the diabase, the pitch being about 40 degrees northwest. The vein, accordingly, becomes generally shorter with depth and apparently dies out at or near the lower contact of the diabase somewhere between the 725- and 900-foot levels.

No. 26 Vein (See Figures 3 and 4). As already stated, this vein has been the largest ore producer in the mine and stoping widths have averaged about 9 feet. The deposit strikes on the average about north 30 degrees west and dips about vertically, except at the northwest end where it is

inclined steeply southwest. The vein pitches to the northwest and ends along or near the hanging-wall and foot-wall contacts of the diabase. The deposit was found to die out toward the northwest on approaching, on the lower levels, a northeast vein, known as No. 10 vein, and, on the upper levels, a sharp bend in the diabase contact which coincides with the projected strike of this vein. In section along No. 26 vein, the trace of No. 10 vein dips 55 degrees northwest, whereas the trace of the foot-wall of the diabase dips about 30 degrees northwest. No. 26 vein, accordingly, becomes progressively shorter in depth and dies out about 50 feet or less below the 750-foot level. To the southeast the vein has been traced up the pitch, beyond its intersection with No. 16 vein and as far as the projected strike of the upper 08 vein. It has been stoped to a maximum of about 160 feet above the 300-foot level. At the southeast end the top of the stope is vertically beneath No. 4 vein, which is exposed on the surface near the hanging-wall of the diabase (locality 8, Map 464A), and which now appears to be part of No. 26 vein although striking somewhat more westerly.

By the end of 1937 almost all the ore had been mined from No. 26 vein. On the 300-foot level ore was continuous for practically the full 700-foot length, except at the southeast end where the vein approached the upper 08 shear. The stopes were especially wide at the intersection with No. 16 vein. On the 450-foot level the vein passed into an indefinitely bounded stockwork of low-grade material on both sides of the intersection with No. 16 vein and, consequently, No. 26 vein was separated into two ore-bodies, one to the northwest and the other to the southeast. The low-grade material in the vicinity of the intersection continues to the 600-foot level and the northwest ore-body continued below this level, but the southeast ore-body died out on approaching the lower contact of the diabase between the 450- and 600-foot levels.

No. 32 Vein (See Figure 3) has been traced for a length of about 200 feet on the 600-foot level, where it follows a crooked course striking on the average about north 25 degrees west. The downward continuation of this vein has been drifted on for 80 feet on the 725-foot level, where it strikes north 55 degrees west. The indicated dip from one level to the next is steeply northeast. On the 600-foot level the breccia zone in which the vein material has been deposited is offset about 20 feet to the left by a northeasterly striking shear zone along which No. 09 vein has been deposited. On the 725-foot level No. 32 vein has been traced southeast to this shear, but has not been found on the other side of it. To the northwest the vein strikes toward No. 14 vein on the 600-foot level, but is not known to be connected with it across the intervening distance of 170 feet.

No. 36 Vein (See Figures 3 and 4) has been developed for a drift length of 250 feet on the 1,050-foot level and for 150 feet on the 1,200-foot level, and has been stoped for a short distance above the 1,050-foot level. The average width for the drift length on the 1,050-foot level is 12 feet. The deposit strikes north 55 degrees west. It dips 77 degrees northeast between the two levels and 77 degrees southwest above

the 1,050-foot level. Between the two levels the pitch is about 40 degrees northwest.

At the southeast end of the drift on the 1,050-foot level quartz stringers of No. 36 vein swing along an easterly striking shear zone and merge with vein material deposited in this zone, which is probably a part of No. 12 vein. If No. 36 vein does not extend beyond this shear, which dips steeply north, the vein would be expected to die out on approaching the upper contact of the diabase, somewhere below the 900-foot horizon. No. 36 vein strikes approximately toward No. 04 vein, suggesting that the two may be on the same general zone of fracturing.

On the 1,050-foot level, at about the centre of the drift, the deposit crosses a dyke of fine-grained grey rock striking about east. On the 1,200-foot level the deposit passes into stringers and dies out or becomes very weak at both ends of the drift as it meets similar dykes.

No 38 Vein (See Figure 4) was discovered late in 1937 on the 1,500-foot level. It merges with the northeasterly striking No. 16 vein at this horizon and has been followed by drifting for 160 feet northwesterly from the junction.

Gabrielle No. 1 Vein (locality 5, Map 465A). In early work by Gabrielle Gold Mines, Limited, a prospect shaft was sunk to a depth of 52 feet on this deposit and 38 feet of drifting was completed.¹ In 1928 the vein was tested by diamond drilling. The deposit is exposed for a length of 65 feet between the shaft and the shore of Rice Lake and varies from 5 to 10 feet wide. It strikes about north 5 degrees west, considerably more nearly north than other northwest veins but, nevertheless, resembles the other veins in general characteristics.

Gabrielle No. 2 Vein (locality 4, Map 465A) has been exposed by stripping for a length of 50 feet along the strike of north 65 degrees west. It consists of a zone of quartz lenses and stringers distributed across widths up to 8 feet.

Gabrielle No. 3 or No. 34 Vein (locality 6, Map 465A). This deposit, unlike all the other veins described, lies in porphyritic andesite. Early work on the deposit was done by Gabrielle Gold Mines, Limited, and consisted of trenching, shaft sinking to a depth of 66 feet, 4 feet of crosscutting, and 72 feet of drifting.² In the autumn of 1935 San Antonio Gold Mines, Limited, did some surface trenching on the vein and tested the deposit in seven diamond drill holes. The company reported that this work resulted in disclosing an ore-body 202 feet long with a value of 0·30 ounce over a width of 7·4 feet, and it was estimated that 20,000 tons of ore were indicated. During the summer of 1936 a crosscut was extended from the 450-level workings of the San Antonio claim, the vein was followed by drifting for 450 feet at this horizon, and a low-grade ore shoot was found to extend for 160 feet of this distance.

The porphyritic andesite in which the vein lies has a cleavage striking north 75 degrees west and dipping 60 degrees northerly. The vein strikes north 35 degrees west, dips 65 degrees northeast, and pitches about 60

¹ DeLury, J. S.: Mineral Deposits in Southeastern Manitoba; Manitoba Bulletin 1920, p. 32.

² De Lury, J. S.: Mineral Deposits in Southeastern Manitoba; Manitoba Bulletin 1921, p. 32.

degrees to the northwest. On the surface the vein zone is exposed almost continuously for a length of 270 feet. Several lenses of quartz occur at intervals along the strike, the largest being 120 feet long and up to 8 feet wide. Numerous stringers of quartz branch outwards from the large lenses and extend laterally for a few feet along the easterly striking cleavage planes of the wall-rock. The lenses and stringers are abundant across widths of 8 to 15 feet. Schistose structure along the strike of the deposit is not well developed. On the 450-foot level the vein is much the same as on the surface and pinches out a short distance from the northwest end of the drift. Shearing along the zone is much stronger than at the surface and continues northwest beyond the end of the vein.

The quartz of the deposit is white, carries small amounts of iron carbonate, red feldspar, pyrite, and chalcopyrite, and is crossed in many directions by crenulated lines of very fine-grained black tourmaline. The pyrite is present in most places as widely scattered small grains, but in places forms shreds of fine-grained material said to assay high in gold. The andesite for a foot or more from the vein material is generally much altered to rusty-weathering carbonate and carries scattered cubes of pyrite. Pyrite is more plentiful in the wall-rock than in the quartz. The vein resembles in some respects the northwest veins in the diabase on the San Antonio and Gabrielle claims.

NORTHEAST SET OF VEINS

The veins of the northeast set as a rule strike between north 60 degrees east and north 75 degrees east. They commonly dip at an angle of about 60 degrees to the northwest, although local rolls in the veins give dips as low as 35 degrees. These veins follow shear zones along which there has been movement of one wall with respect to the other, the displacement having been to the left. The veins curve slightly along the strike, but are not tortuous like the northwest veins. The largest vein of this type, No. 16 vein, shows drift lengths up to 620 feet, and it extends from the surface or near the surface to a vertical depth of at least 1,500 feet, the lowest level of the mine. Ore lengths are shorter than the drifts, and the average stoping width has been approximately 4 feet. This vein has been the second largest ore producer in the mine. Other veins of the northeast set include the lower 08 vein and the upper 08-09 vein.

The veins of the northeast set generally strike at angles of from 60 to 70 degrees to the strike of the enclosing diabase and pitch to the northeast at steeper angles than the pitch of the northwest veins. Branch veins occur in places; these strike and dip nearly parallel to the main veins, which they meet at acute angles. The northeast veins die out in stringers as the contacts of the diabase are approached. Some of the shear zones along which the veins have been deposited also die out or become very weak within a short distance of these contacts, but at least one shear apparently continues beyond a contact and offsets it. At several localities the northeast shears cross the northwest fracture zones and displace them to the left. The vein material, however, swings from one set of openings to the other.

Along the northeast shear zones schistose structure is generally well developed and the cleavage lies parallel to the trend of the zone. A main quartz vein commonly lies along the central part of the schist zone and is paralleled on both sides by numerous quartz stringers. A few of the subsidiary stringers cross one another, but breccia structure is not characteristic, as it is in the northwest veins. The quartz of the main vein has a banded structure which parallels the walls of the vein and the schistosity of the wall-rock. The banding is due to the presence in the quartz of streaks of finely crystalline pyrite and to long shreds and bands of chloritic schist like the schist on the walls. The quartz along the pyrite streaks is dark grey, whereas most of the quartz elsewhere is white, and this difference in colour further accentuates the banding.

The quartz carries the same suite of minerals as occur in the northwest veins and in about the same proportion, with pyrite as the dominant sulphide and gold, chiefly with the fine pyrite. Gash veinlets of quartz are somewhat more noticeable; they cross the banding and the pyrite streaks of the main veins almost at right angles, do not generally extend beyond the edges of the main vein, and where well developed form a ladder-like structure. There is no noticeable change in mineralization with depth in either the northeast or the northwest veins.

At a few localities the wall-rock is altered to a grey albite-carbonate rock like the altered material along the northwest veins. This type of alteration is especially noticeable on the lower levels along No. 16 vein, but elsewhere occurs only at scattered localities and in small amount. The typical alteration is to a dark green chloritic schist carrying shreds and flakes of sericite and disseminated cubes of pyrite, which are most abundant near the main vein. Remnants of quartz and leucoxene, constituents of the normal rock, remain in the schist. The pyritized wall-rock generally carries only very little gold.

Lower 08 Vein (See Figure 3). This vein has been developed on the 600-, 725-, 900-, and 1,050-foot levels. On the 600-foot level the strike is north 75 degrees east, whereas with depth the vein gradually swings more northerly until on the 1,050-foot level it trends about north 60 degrees east. It dips northwest at an average angle of about 65 degrees and rakes to the northeast. Drift lengths on the four levels vary from 130 to 240 feet. At the southwest end on the 600-foot level and in a stope above this level the vein splits into two branches.

Upper 08 and 09 Veins (See Figure 3). On the 600-foot level the 09 vein lies some 150 feet southeast of the lower 08 vein, and has been developed on this level and on the 725-foot level. The upper 08 vein is now known to be the upward continuation of the 09 vein, and has been developed on the 300- and 450-foot levels. Like the lower 08 vein the deposit dips northwesterly, pitches northeast, and gradually changes in strike with depth; on the 300-foot level it strikes about east, whereas on the 725-foot level it trends about north 75 degrees east. The vein varies from 1 foot to 4 feet wide. Drift lengths on the four levels range from 150 to 300 feet. Some stoping has been done from the upper two levels. On the 300-foot level the vein passes into irregular stringers at

the southwest end, but the shear continues at least 60 feet farther, to the end of No. 26 vein. The upper 08 vein does not outcrop, but if assumed to continue up the pitch would lie beneath a bay of Rice Lake and a drift depression 200 feet northwest of No. 2 shaft.

No. 10 Vein (See Figure 3) was intersected on the 450-foot level in a crosscut that connects the underground workings of the Gabrielle section with those on the San Antonio section. The vein has now been explored by drifting for lengths of 80 to 150 feet on the 450-, 600-, and 900-foot levels. The deposit consists of veins and stringers of quartz that follow a strong shear and fracture zone up to 10 or 15 feet wide. The shear zone along which the vein material has been deposited strikes about north 65 degrees east and dips 60 degrees northwest. On several levels on the projected strike of the shear, the north contact of the diabase, as indicated by diamond drilling, deviates sharply from its usual strike in such a manner as to suggest that the contact may have been displaced about 200 feet by movement along this shear. The sharp deflection in the contact, however, may have been the result of the intrusive following a pre-diabase fracture, and the No. 10 shear may have developed along this early zone of weakness without any such large displacement.

No. 11 Vein was found on the Gabrielle claim near the east boundary on the 450-foot level (See Figure 4). It was discovered in a crosscut that connects the underground workings of the Gabrielle section with those of the San Antonio section. The vein consists of stringers and veins of quartz up to 2 feet wide in a shear zone explored by drifting for about 80 feet along the strike of north 65 degrees east. The deposit crosses a constricted part of the diabase, only about 180 feet wide.

No. 16 Vein (See Figure 3). As already stated, this vein has been the second largest ore producer in the mine, and the average stoping width has been about 4 feet. The vein has been developed by drifting on nine levels and the ore has been largely stopeed out above the 725-foot level. On the 300-foot level the vein strikes north 75 degrees east; in depth, the strike gradually swings more northerly until on the 725-foot level it strikes north 50 degrees east. Below this level the strike gradually swings back again to about north 70 degrees east on the 1,500-foot level. The dip is to the northwest and averages about 60 degrees, although varying slightly from place to place, and at one locality a roll gives a dip as low as 35 degrees. A section along the vein shows the trace of the upper and lower contacts of the diabase pitching about 55 degrees northeast and the vein also pitches, on the average, at about this angle.

On the 600-, 725-, 900-, and 1,050-foot levels the distance across the favourable diabase formation, as measured along the strike of the vein, varies from 630 to 700 feet; drift lengths are shorter and vary from 420 to 620 feet; ore lengths are generally shorter than the drifts, and on the 600- and 725-foot levels the vein for 200 to 250 feet from the southwest end is discontinuous and is below ore grade except for a small shoot of good ore at the intersection with No. 26 vein on the 600-foot level. With this exception, the ore on these and other levels occurs mainly in the northeast part of the vein, but values drop before the upper

contact of the diabase is reached. Below the 1,050-foot level the vein has not yet been fully developed, but has lengths up to at least 240 feet. Above the 600-foot level the vein has not been traced by drifting for distances greater than 50 feet southwest of its intersection with the vertically dipping No. 26 vein. Northeast of the intersection the drifts extend to the diabase contact and, because of the dip of the upper contact of the diabase, shorten from 430 feet on the 450-foot level to 250 feet on the 300-foot level. Assuming that the vein continues up the pitch and beyond the intersection with No. 26 vein, it should be found beneath drift about 280 feet southeast of No. 3 shaft. Exceptionally low water in the lake is said to have revealed a quartz vein on the shore at this locality.

No. 24 Vein (See Figure 3) branches off from the foot-wall side of No. 16 vein at a point about half-way between the 600- and 725-foot levels. No. 24 vein dips more gently than No. 16 vein, so that on the 725-foot level it is 20 to 60 feet from this vein, but striking roughly parallel to it. On the 725-foot level it has been followed by drifting for 250 feet and has been stoped for 30 or 40 feet above this level.

Gabrielle No. 6 Vein. This is the most important vein within the diabase in the Gabrielle section of the mine. It has been developed from the main Gabrielle shaft, which is located on the Gabrielle claim at a point 380 feet north of the lake. The vein has been followed by drifting for 330 feet on the 200-foot level (See Figure 4) and for 480 feet on the 320-foot level. The east end of the drift on the 200-foot level is 180 feet south 18 degrees west of the shaft. The vein strikes about north 80 degrees west and dips 60 degrees north. The deposit follows a strong shear and fracture zone along which there has been considerable movement, as shown by the fact that a dyke of feldspar porphyry is cut off on the south side of the drifts but does not appear again on the north side, and that the northwest contact of the diabase has been displaced along the shear.

Vein quartz has been introduced as lenses and stringers at intervals along the zone, but is generally not plentiful for lengths of more than 50 or 100 feet at any one locality. Fine-grained pyrite occurs sparingly as thin bands.

FAULTS

In addition to the two sets of veins, there are many small faults in the diabase. These are narrow fractures or shear zones which may, or may not, be filled with vein quartz. The vein quartz is generally low in grade or barren, and such deposits are not classed as veins by the mine staff. In places, however, small amounts of ore have been recovered from the quartz-filled faults, and no sharp distinction can be made between them and the veins. Most of the faults lie about parallel to the northeast veins, and from a structural standpoint may be grouped with the northeast set. These faults, like the northeast vein shears, cross the northwest fracture zones and offset them to the left. One fault strikes about north, dips steeply east, and does not belong to either of the previously mentioned sets. This fault crosses both the northwest and

northeast sets and displaces them to the right. Another fault strikes northwest and dips steeply southwest. It strikes parallel to the northwest set of fractures but, unlike these fracture zones, shows movement of one wall with respect to the other. This fault crosses a shear of the northeast set, and also the northerly striking fault, and has offset them to the right. The north fault is offset to the left by one of the northeast faults.

At some intersections of faults with veins the quartz, in part at least, swings from one type of opening to the other, even where the fault offsets the shear or fracture zone in which the vein has been deposited. More commonly, however, barren quartz of the faults cuts across mineralized quartz of the veins. There was, accordingly, some overlapping in the order of development of the various fractures, shears, and faults, and vein material was apparently introduced over a considerable period of time as channels became available. The earlier solutions caused most of the wall-rock alteration and brought in most of the gold, only barren solutions remaining to deposit quartz in the latest faults.

FORTY FOUR MINES, LIMITED

This company was incorporated on January 12, 1934, to explore favourable territory lying immediately east of the ground held by San Antonio Gold Mines, Limited. The following claims are held: Rice, Rice No. 1, Cyanide fraction, Sundog, Sandwich fraction, Big Rice Lake fraction, Sandy Lake fraction, Incline, Rachel fraction, Rachel, "44," "45," and "47."

Exploration work has been concentrated on the easterly extension of the diabase beneath Rice Lake. During the winter of 1934 this formation was traced by diamond drilling, and the cores showed some vein material with encouraging values. An agreement was then made with San Antonio Gold Mines, Limited, to explore the veins underground, and a long crosscut was driven on the 600-foot level southeasterly to a point at about the middle of the Big Rice Lake fraction. Further diamond drilling was completed laterally from the crosscut. Four veins were located in the diabase and during 1935, 241 ounces of gold were produced from 1,068 tons of ore treated in the San Antonio mill. Work was then suspended on the property. The drilling and underground work indicate that the diabase lies in sediments, dips from 40 to 50 degrees northeasterly, and generally varies from 150 to 200 feet in thickness. The veins, like those on the San Antonio claim, belong to two sets, one striking northwest and the other striking northeast.

NORTHEAST VEINS

No. 45 Vein had been found on the 600-foot level near the central part of the Rice claim (See Figure 4). The diabase at this locality is 400 feet wide as measured horizontally, and the vein lies toward the hanging-wall side of the intrusive body. The deposit strikes on the average about north 85 degrees east and dips northerly. It extends for about 150 feet along a drift and apparently dies out at both ends. It has been partly stoped out and the inclination of the stope indicates that the deposit rakes to the west.

The vein consists of a succession of quartz lenses up to 3 feet wide, which together with small stringers and branch veinlets give stoping widths of 10 to 15 feet. The quartz is mixed with carbonate and is mineralized with disseminated grains and streaks of finely crystalline pyrite. Pyrite is plentiful in the diabase along the vein zone. Some gash veinlets of quartz, which appear to originate in the central part of the larger lenses, cut the outer parts of the lenses and the pyrite streaks, and continue for a few inches into the wall-rock. At the west end the vein dies out in a dyke of grey rhyolitic rock about 20 or 30 feet wide.

No. 45 West Vein commences on the other side of this dyke at a point close to the projected strike of No. 45 vein. This vein has been traced for 150 feet to the west and crosses the boundary between the Rice claim and the Island fraction (See Figure 4). It dips 70 degrees north. This deposit comprises irregular veinlets of quartz lying along a narrow shear zone. The quartz and wall-rock are mineralized with pyrite.

NORTHWEST VEINS

No. 46 Vein lies about 50 feet east of No. 45 vein and strikes about north 50 degrees west. It has been explored by drifting and some stoping for a length of about 100 feet. It lies for the most part in the diabase close to the hanging-wall, and has been traced for about 30 feet beyond the contact into the sediments (See Figure 4).

The deposit consists of irregular quartz veinlets and stringers striking in various directions across widths of 10 feet or so. The quartz carries fine-grained pyrite and visible gold. Some gold was also found in the section of the vein that lies in the sediments.

No. 47 Vein lies in the central part of the Big Rice Lake fraction, where the diabase is between 100 and 200 feet wide horizontally. The vein has been explored by diamond drilling from the surface and by drifting for 280 feet on the 600-foot level. In the drift the vein follows a crooked shear and fracture zone that strikes about north 30 degrees west and dips 70 degrees northeast. The northwest part of the vein has sediments along the hanging-wall and diabase along the foot-wall; the reverse is true along the southeast section, and for a short distance along the central part of the vein diabase lies on both walls (See Figure 4). It appears, therefore, that the vein may lie along a fault that has offset the diabase to the right, the displacement having been about 100 feet.

A main quartz vein extends for the greater part of the drift length and pinches and swells along the strike from 2 feet or less to 5 feet wide. Many subsidiary veinlets either lie parallel to the trend of the zone or cross one another in various directions and extend laterally for 5 feet or more on both sides of the main vein. The quartz is white and carries patches of carbonate and disseminated grains and a few streaks of pyrite. The sediments and diabase along the vein zone are slightly altered to carbonate and carry large cubes of pyrite. A few gash veinlets of quartz mixed with carbonate cross the main vein and the stringers at about right angles.

CYANIDE FRACTION

Some exploratory work has been done in rocks other than the sill of diabase. Such work includes some diamond drilling beneath the lake on the Cyanide fraction (See Map 459A). The holes passed through fine-grained, dark green, schistose, basaltic rock to the north and coarser grained gabbro to the south. Some material well mineralized with pyrite was recovered from the cores, but assays are said to have been disappointingly low.

NORMANDY GOLD MINES, LIMITED

PROPERTY AND DEVELOPMENT

Normandy Gold Mines, Limited, was incorporated on August 1, 1934, succeeding Normandy Mines, Limited. The company's office is at 703 McIntyre Block, Winnipeg, Manitoba. Property held by the company extends northeasterly from the east end of Rice Lake and includes the following eighteen claims and fractions: Big Horn, Barbara Ann, Eleven, Maria, Rabyauk No. 2, Rabyauk fraction, Normandy No. 2 and No. 6, Gimli No. 1 and No. 2, Hunter No. 1 to No. 6 inclusive, Florence fraction, and Park.

Gold is reported to have been discovered on the property in 1912 by Begge Thordarson, but little work was done until the summer of 1934, when three deposits were opened up by trenching and test pitting. During the winter of 1934-35 some 3,000 feet of diamond drilling in seven holes was completed. Work on the claims was then suspended.

GEOLOGY

The most abundant rock type on the property is arkosic and tuffaceous sediment, forming a band 2,400 feet wide near Rice Lake and narrowing along its northeast trend to 400 feet near the north edge of the map-area. Bedding in this rock strikes northeast and dips from 70 to 80 degrees northwest. Associated with the sediments are narrow bands of rhyolite and of basalt, the latter showing pillow structure on some outcrops. These rocks are overlain to the northwest by fragmental trachyte and porphyritic andesite. To the southeast is a large intrusive body of meta-gabbro, meta-diorite, and quartz diorite. The sediments and associated rhyolite and basalt have been intruded by several sill-like bodies of meta-diabase. The diabase and other rocks are cut by a few small dykes of porphyry.

The band of sediments, volcanics, and diabase is a northeasterly continuation of the formations that cross the property of San Antonio Gold Mines, Limited, and Forty-Four Mines, Limited, and it is interesting to note that the diabase sill in which ore occurs on the San Antonio claim continues through the property. It is much narrower than at the San Antonio mine, however, where almost all the ore occurs in a section where the sill is about 500 feet wide. On the property of Normandy Gold Mines, Limited, this sill varies from 50 to 200 feet wide.

Another sill of similar diabase on the property varies from 50 to 100 feet wide, and a third sill, which outcrops in the southeast corner of the Hunter No. 3 claim, is apparently 320 feet wide. The latter body is not exposed continuously for this width and outcrops for only 750 feet along the strike, passing beneath extensive areas of drift at both ends.

VEINS

Three mineral deposits are known to occur on the property. They strike northeasterly about parallel to the trend of the rock formations and dip either northwest or southeast. The deposits consist of shear zones holding lenses and veins of quartz which carries carbonate, pyrite, and, in places, chlorite, red feldspar, and tourmaline. One of the deposits occurs in diabase, another lies in rhyolite, and the third is in arkosic sediment. Low assays in gold have been reported.

No. 1 Deposit (locality 20, Map 463A) crosses the northern part of the outcrop of diabase on the southeast part of the Hunter No. 3 claim. The deposit follows a shear zone that strikes north 55 degrees east, dips 85 degrees northwest, has been traced for 200 feet on natural outcrops and in two prospect pits, and has been tested by one diamond drill hole. Schistose diabase along the zone varies from 3 feet to 5 feet wide. In places, a few small quartz lenses have been introduced along cleavage planes of the schist. Shreds of schist included in the quartz lenses carry disseminated grains of pyrite.

No. 2 Deposit (locality 19, Map 463A) is in the southeast part of the Hunter No. 3 claim and the southwest part of the Hunter No. 2 claim. The deposit lies along a shear zone that occupies a steep-walled depression along which a small creek flows. The depression is about 50 feet wide and is bordered on the southeast by a diabase sill and on the northwest by fragmental porphyritic andesite.

The schist zone has been traced in seven trenches and two diamond drill holes for a distance of 550 feet along the strike of north 60 degrees east. Schist along the zone dips steeply north and apparently occupies much of the full width of the depression. The diabase sill is slightly sheared along the edge of the deposit, but most of the material in the depression is sheared rhyolite. Irregular bodies of grey and pink albitite occur in places in the zone. The sheared rhyolite and albitite are penetrated here and there over much of the full width of the zone by lenses, and stringers of white and grey quartz, which constitute only a small proportion of the material present. The quartz generally carries abundant carbonate, and, in places, a small amount of red feldspar and streaks of very fine-grained black tourmaline and chlorite. Disseminated grains of pyrite are abundant in much of the sheared rhyolite and are less plentiful in the albitite and quartz.

No. 3 Deposit (locality 18, Map 463A) lies in the southwest part of the Normandy No. 2 claim, has been opened up in three prospect pits for a length of 150 feet, and has been intersected in one diamond drill hole. The deposit consists of lenses of quartz lying along a shear zone that crosses pebbly arkose. The body of quartz and schist strikes north

60 degrees east and dips about 80 degrees southeast. Quartz lenses are as much as 35 feet long and 2 feet wide. The schist zone is about 5 feet wide and, in places, several lenses of quartz are distributed across this width. The quartz is white or glassy and carries patches and streaks of chlorite, a few grains of red feldspar, and a little pyrite.

For 500 feet southwest of the deposit the arkose is highly sheared across widths up to 50 feet, but contains only a small amount of vein quartz.

BIG HORN CLAIM (See Map 464A)

Three diamond drill holes were put down beneath Rice Lake on the Big Horn claim. These indicated that the bands of basalt and gabbro that outcrop at the east end of the lake continue beneath the lake across the southeast part of the claim, and that sediments underlie the lake between the basalt and the north shore. Some narrow bands of pyrite were found in the sediments, but no veins of importance are known to have been intersected.

WINGOLD MINES, LIMITED

HISTORY AND DEVELOPMENT

Wingold Mines, Limited, was incorporated on October 27, 1931, with an office at 403 McIntyre Building, Winnipeg, Manitoba. On incorporation the company acquired properties formerly held by Gold Field Mining Company, Limited, Winnipeg Gold Mines, Limited, and Independence Mining Company, Limited. Other claims were purchased later, and in 1936 the company held a block of seventeen claims lying north of Rice Lake and including the following: Michigan, Michigan fraction, Gold Cup No. 2 fraction, Gold Cup, Gold Cup fraction, Doreen fraction, Big Four fraction, Gold Standard, Goldfield, Goldfield No. 1, Emperor, Jumping Cat, Gold Reserve, and Gold Reserve Nos. 1, 2, 3, and 5 claims.

Work completed from 1913 to 1915 by the former operators included shaft sinking and a small amount of lateral work on the Goldfield, Gold Standard, Gold Cup, and Big Four claims, and shaft sinking on the Emperor claim. A small stamp-mill was operated for a short time on the Goldfield claim.

Little or no further work was done on the various claims until the property was taken over by Wingold Mines, Limited, who re-examined the old workings and, in the spring of 1934, installed a mining plant on the Goldfield claim. Electric power was made available over a transmission line from a substation at the San Antonio mine. Buildings were erected in the vicinity of the shaft and on the Gold Cup claim. Deepening of the old shaft commenced on July 4, 1934, and development work was undertaken on levels at 75, 150, and 275 feet, and some diamond drilling was done from the underground workings. After a year's operation the mine was closed down. The company, it is reported, estimated that 10,000 tons of ore carrying \$16 in gold a ton had been developed. In the spring and summer of 1936, over 8,300 feet of diamond drilling in twenty-four holes was completed in exploring surface showings on the Gold Standard, Big Four, and Gold Cup claims and in investigating

possibilities of finding ore beneath a wide area of drift and swamp that extends in an easterly direction through the property. Most of the holes in the area of drift and swamp were put down on the Gold Cup No. 2 fraction. During the early winter of 1936-37 another program of diamond drilling was undertaken to further investigate the possibilities in the vicinity of the shaft on the Goldfield claim.

GEOLOGY

Rocks on the group of claims comprise chiefly coarse-grained porphyritic andesite lava and trachyte breccia. The andesite predominates and forms two broad bands trending in a gentle curve from west in the east part of the area to north 70 degrees west in the west part. The trachyte breccia forms a layer between the two bands of andesite, occurs as a long lens within one of the bands, and underlies a broad stretch of country north of the andesite. Schistose structure is better developed in the breccia than in the more competent andesite. The cleavage strikes parallel to the trend of the bands and dips from 55 to 65 degrees north. The andesite and breccia are cut by dykes of basaltic or diabasic rock which trend easterly to northeast and vary from a foot or less to 20 feet wide. The trachyte breccia is cut by an easterly trending dyke of porphyritic andesite up to 50 feet wide.

VEINS

Almost all of the deposits lie in the porphyritic andesite lava, and most of them occur in the southern, broader band of this rock. One vein lies partly in a dyke of diabasic rock. Most of the deposits strike northwest at angles of 10 to 45 degrees more northerly than the trend of the formations and the regional cleavage, and dip northeast at angles of from 30 to 70 degrees. One vein strikes north 70 degrees east at a large angle to the regional cleavage and dips 60 degrees northwest. Some of the deposits consist of definite quartz veins, whereas others are composed of many quartz lenses and stringers in shear zones in the enclosing rock. Buff-weathering carbonate, red feldspar, chlorite, and black tourmaline are associated with the quartz, and grains and cubes of pyrite are sparsely disseminated in the quartz and wall-rock. All the underground workings were filled with water at the time of the writer's visit and the description of what was found there has been taken largely from data supplied by officers of the company.

No. 1 and No. 2 Veins have been explored in the underground workings on the Goldfield claim. The shaft has been sunk at the base of a high hill of coarse porphyritic andesite in which the veins occur. Bedrock is largely covered in a broad valley to the north, but a few small outcrops of the porphyritic andesite and of coarse breccia near the base of the hill show that the contact between these two types is at a locality about 150 feet north of the shaft.

No. 1 vein outcrops at the east end of the shaft-house (locality 15, Map 464A) and, according to information supplied by the company, has been followed to the northwest in underground workings (See Figure

5). In early work on the property the vein was explored by drifting for 40 feet on the 75-foot level. In later work by Wingold Mines, Limited, the vein was followed by drifting for an additional 110 feet on the 75-foot level and for 250 feet on the 150-foot level. On the 275-foot level what may be the same vein was drifted on for 230 feet.

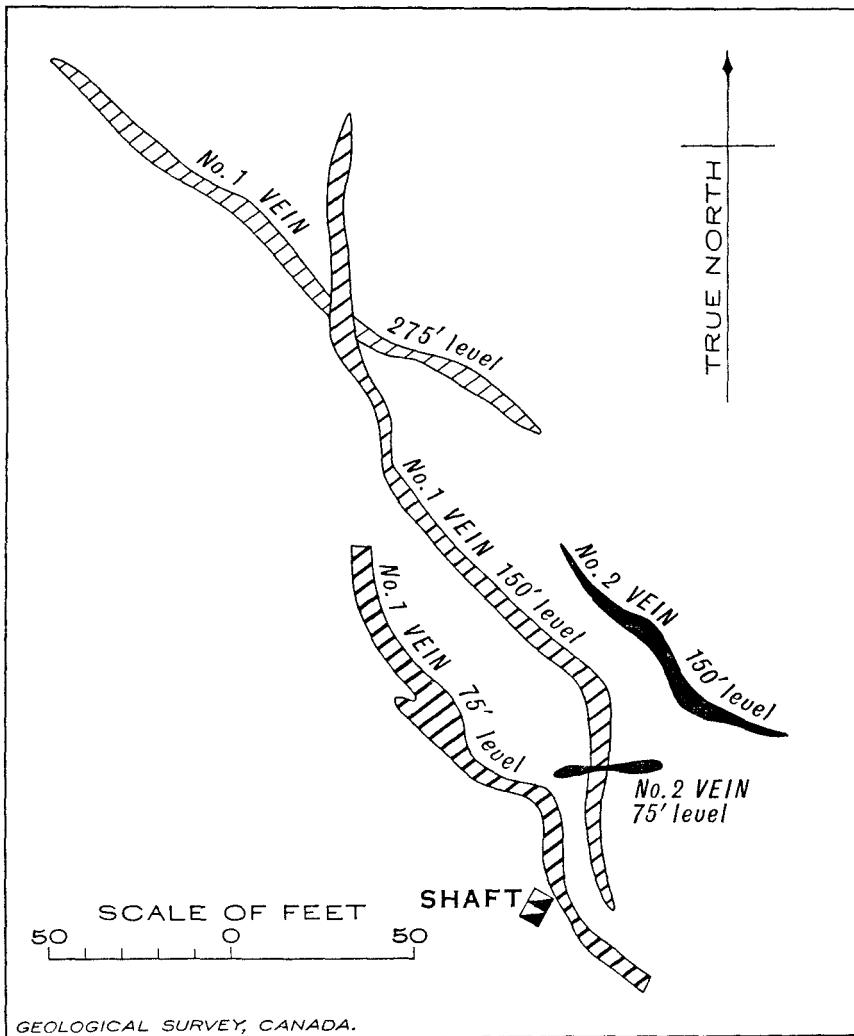


Figure 5. Veins on the Goldfield claim.

On the surface the vein strikes north 45 degrees west, continues for a length of 50 feet to the southeast of the shaft-house, and then pinches out. It crosses the regional schistosity of the porphyritic andesite, which

trends about north 70 degrees west and dips 55 degrees northerly. The vein, which consists of white quartz, varies from 2 to 3 feet wide and is accompanied on both sides by a few quartz stringers. The quartz carries scattered patches of red rhyolitic material, stringers and patches of buff-weathering carbonate and fine chlorite, and irregular streaks of very fine-grained black tourmaline. On the 75-foot and 150-foot levels No. 1 vein follows a crooked course, striking on the average about north 30 degrees west and dipping about 70 degrees northeast. The deposit on the 275-foot level strikes north 50 degrees west. On the two lower levels the deposit is reported to be a strong quartz vein and on the bottom level a high-grade ore shoot extended for a length of 15 feet.¹ On both the lower levels the vein died out in porphyritic andesite a short distance from the breccia contact.

No. 2 vein (See Figure 5) has been developed on the 75-foot and 150-foot levels and has been followed in a raise between these two levels. The deposit strikes west on the 75-foot level, and dips steeply northerly to the 150-foot level, where it trends north 40 degrees west. Drift lengths are 25 feet and 80 feet, respectively, on the two levels. Fair assays were obtained over a length of 40 feet on the 150-foot level² and some good ore was found in the raise and on the 75-foot level. The deposit has not been found on the 275-foot level. Other small veins are reported to have been found underground.

The quartz on the mine dump is white, is sparsely mineralized with disseminated grains of pyrite, carries carbonate, and is crossed by many lines of fine-grained black tourmaline. The porphyritic andesite adjacent to the vein quartz is altered to a sericitic and chloritic schist holding disseminated cubes of pyrite. Gold is said to have been seen in some of the quartz in the underground workings.

No. 3 Vein Zone (locality 14, Map 464A) was located by diamond drilling during the winter of 1936-37. According to the logs of the drill cores kindly supplied by the company, this deposit comprises a broad shear zone penetrated by numerous stringers and veins of quartz across widths of 10 to 50 feet. The zone strikes north 60 degrees west and dips about 65 degrees northeast. It has been traced for 250 feet northwest and 150 feet southeast of the shaft, and has been cut at vertical depths of 300 feet or less in twelve holes and at a depth of 725 feet in one hole. Low gold values were found at intervals in each of the intersections and, locally, some encouraging assays were obtained. Southeast of the shaft the zone apparently coincides with No. 1 vein. For 550 feet farther southeast a narrow drift depression lies along the projected strike of the deposit. The fact that this depression trends at an angle to the regional schistosity of surrounding rocks suggests that it is underlain by a shear zone. If so, it is probably a continuation of No. 3 zone.

On the hillside just south of No. 1 vein, numerous short lenses and stringers of quartz lie, *en échelon*, along cleavage planes of the porphyritic andesite, but the deposit as a whole trends north 40 degrees west at a considerable angle to the cleavage. This deposit may be part of the

¹ Seventh Annual Report, Manitoba Department of Mines and Natural Resources, Mines Branch, p. 81.
² Op. cit., p. 81.

broad No. 3 zone. The deposit of mixed quartz and porphyritic andesite is about 20 feet wide and extends for 150 feet southeast of the shaft-house. The quartz lenses are up to 3 feet wide and 20 feet long, and in places carry much black tourmaline and small amounts of carbonate and pyrite.

No. 4 Vein (locality 11, Map 464A) lies on the top of a high ridge in the central part of the Gold Cup claim. Early work on the deposit included sinking a shaft variously reported to be from 60 to 100 feet deep, with some lateral work. The shaft was sunk on a shear zone that follows a dyke of basaltic or diabasic rock 10 feet wide, cutting porphyritic andesite. The dyke strikes north 53 degrees west and dips 60 or 65 degrees northeast. The shearing dies out a few feet southeast of the shaft. In depth the shear zone apparently passes out of the dyke, for a diamond drill hole placed so as to pass beneath the shaft intersected quartz stringers in sheared porphyritic andesite on the foot-wall side of the dyke at a depth of about 150 feet down the dip. The sheared andesite in the core carries a few cubes and grains of pyrite. Most of the material on the dump at the shaft is sheared porphyritic andesite, which is cut by stringers of quartz and carbonate, carries cubes of pyrite, and is much altered to carbonate.

A pit on the dyke and at the edge of the outcrop 220 feet northwest of the shaft shows a width of 3 feet of diabase much altered to carbonate, with some pyrite, and cut by veinlets of a mixture of quartz and carbonate. Four drill holes have been put down beneath drift at intervals for 400 feet northwest of the pit. A hurried examination of the cores indicated that the dyke pinches out about 100 feet from the outcrop and that a zone, some 20 feet wide, carrying many stringers of quartz extends for 100 feet beyond the end of the dyke.

No. 5 Vein (locality 12, Map 464A) lies on the Big Four fraction. During early operations a shaft was sunk on the deposit and is reported to be 100 feet deep with some crosscutting. Material on the dump is porphyritic andesite with only small amounts of white quartz carrying much fine-grained chlorite and a little carbonate and pyrite. The vein outcrops at a point 40 feet easterly from the shaft and pinches out 10 feet farther east. It is a lens of white quartz $2\frac{1}{2}$ feet wide.

In three diamond drill holes a zone of quartz stringers was intersected for 200 feet along the strike and at depths of 120 to 200 feet, as measured down a dip of about 55 degrees north from the surface outcrop. The cores show grains of pyrite disseminated through sheared, porphyritic andesite near some of the stringers.

No. 6 Vein (locality 13, Map 464A) outcrops in the central part of the Gold Standard claim. During early operations, when the claim was known as the Independence claim, the deposit was explored in a prospect shaft and some drifting was done. Another shaft was sunk in porphyritic andesite nearby.

Porphyritic andesite in which the deposit lies has a regional schistose structure striking north 65 degrees west and dipping 55 degrees northerly. The vein strikes north 70 degrees east and dips 60 degrees northwest.

It is continuously exposed in a rock cut for a length of 70 feet. The vein pinches and swells along the strike from 1 foot to $3\frac{1}{2}$ feet wide, and at one locality sends a short branch vein into the hanging-wall rock. At the southwest end of the trench the vein fingers out into stringers. The shaft has been sunk at the northeast end of the trench, beyond which the vein passes beneath a small area of drift. A diamond drill hole beneath the drift cut quartz stringers on the strike of the vein at a point 70 feet northeast of the shaft. Two drill holes were put down beneath the trench and intersected quartz veins and stringers at a depth of about 100 feet down the dip of the deposit. A fourth drill hole crossed the projected strike of the deposit just southwest of the trench, but failed to locate the vein.

The quartz along the vein on the surface and on the dump at the shaft is white, locally carries buff-weathering carbonate and red feldspar, and is cut by tiny veinlets of red albite and black tourmaline. Porphyritic andesite adjacent to the vein quartz is schistose, and in places on the dump and in the drill cores carries a few disseminated cubes and grains of pyrite.

No. 7 Vein (locality 16, Map 464A) outcrops on the Goldfield No. 1 claim. The deposit has been traced by stripping and two shallow prospect pits for a length of 250 feet along the strike of north 65 degrees west. The vein, which consists of quartz, pinches and swells along the strike from $\frac{1}{2}$ foot to 2 feet wide, and in places breaks up into several stringers distributed across widths up to 5 feet. The quartz carries small amounts of red feldspar, buff-weathering carbonate, and fine-grained, massive, green chlorite.

No. 8 Vein (locality 17, Map 464A) outcrops near the top of a high ridge of coarse porphyritic andesite near the central part of the Emperor claim. The quartz vein is narrow, and is exposed for 130 feet along a curved course averaging about north 75 degrees east. The deposit apparently dips about 70 degrees northwest and carries a small amount of pyrite. A prospect shaft, variously reported to be from 40 to 69 feet deep, has been sunk vertically at a point 30 feet northeast of the outcrop of the vein. The shaft, apparently, did not intersect the vein for only country rock was seen on the dump.

The deposit lies on the projected strike of a rhyolite dyke that follows a fault zone across the "45" and Rachel claims. The vein on the Emperor claim probably lies in this disturbed zone, although the dyke pinches out somewhere southwest of the vein.

GOLD CUP NO. 2 FRACTION (See Map 464A)

The diamond drill holes that were put down on this claim in 1936 crossed a broad band of porphyritic andesite bordered to the north and south by volcanic breccia. No important amounts of vein quartz were intersected in the breccia. In the porphyritic andesite, however, each of the six holes, which were drilled at intervals of about 200 feet along the strike of the formations, cut one or two zones containing many stringers and bodies of quartz. The zones varied from 2 to 6 feet wide and intersections of quartz bodies were up to 2 feet wide. Sulphides

are sparse or lacking in most of the quartz and nearby rock, but disseminated small grains of pyrite were seen in the core of one of the quartz bodies.

RICE LAKE GOLD MINES, LIMITED

PROPERTY AND DEVELOPMENT

Rice Lake Gold Mines, Limited, was incorporated on April 9, 1934, succeeding Rice Lake Gold Syndicate which, in 1933, had succeeded San Antonio Extension Syndicate. The company's office is at 200 Bay Street, Toronto, Ontario.

The company holds a large group of claims located east and southeast of Rice Lake and including the following: Reno, Reno No. 1, Reno fraction, Combine Nos. 1, 2, 5, 6, and 7, Combine No. 3 fraction, Charles, Vincent, San Antonio Extension, San Antonio Extension No. 1, San Antonio Extension fraction, San Antonio Extension fraction No. 1, Ruby, Ruby fraction, Golden Rod, Golden Rod No. 1, Gold Nos. 1 to 6, Gold fraction, Rita, Rita Nos. 1 to 6, Rita No. 1 fraction, Rita No. 3 fraction, Rita No. 10 fraction, and Thelma.

Following preliminary work on some of the claims, Rice Lake Gold Mines, Limited, undertook, in 1934, an extensive program of surface trenching and diamond drilling. Drilling was resumed in 1935, and again in 1936. In all, about 6,800 feet of diamond drilling was completed. Cabins have been built on the Combine No. 2, Golden Rod, and Rita No. 1 claims.

GEOLOGY

Rocks on the property include chiefly rhyolite, trachyte, andesite, porphyritic basalt, and volcanic breccia. These rocks are cut by a variety of dyke rocks, the oldest of which comprise two dykes of porphyritic andesite striking east and southeast. A younger dyke of meta-diabase strikes northeasterly across the property. The youngest dykes of all occur in large numbers, generally trend from northeast to north, and consist of feldspar porphyry and quartz-feldspar porphyry.

VEINS

Many shear zones have been found on the property. Most of them strike from north 10 degrees west to north 45 degrees west and dip from 50 degrees northeast to vertical. One zone, called No. 1 zone, or the Independence vein, strikes north 35 degrees east, nearly at right angles to the dominant type, and dips steeply northwest. The northwest shears cross many dykes, and in almost every case have offset them to the right. The northeast shear, or Independence vein, displaces a dyke to the left. Schist along several of the zones has been dragged in the direction of displacement of the dykes. The maximum displacement of dykes as measured horizontally along the shear is 1,500 feet; usually it is much less. The shear zones are up to 20 feet or more wide, but are commonly less than 10 feet wide. They have been traced intermittently along the strike anywhere from 150 to 4,300 feet.

Vein quartz occurs in most of the zones, but is commonly distributed very erratically, and considerable stretches of sheared rock along many of the zones are without vein material. Most of the quartz carries buff-weathering carbonate, chlorite, and, rarely, a little sericite and red feldspar. Pyrite is in most cases not plentiful, but is present in some of the quartz and has been noted in the wall-rock as well. A small amount of chalcopyrite was seen in one deposit.

Most of the surface work and drilling have been concentrated on two deposits, which may be called No. 1 and No. 2 zones. A small body of good grade vein material is reported to have been indicated in No. 1 zone, but elsewhere assays are said to be generally low.

No. 1 Zone (locality 36, Map 460A), or the Independence vein as it is sometimes called, has been traced for a length of 2,200 feet across the Rita No. 1 claim and the Rita No. 1 fraction. The vein strikes north 35 degrees east and dips from 75 to 80 degrees northwest. Workings on the vein consist of a prospect shaft, 30 feet deep, about thirty prospect trenches, and nineteen diamond drill holes.

During the summer of 1934 the company sampled the surface workings and obtained encouraging assays in the shaft and in nearby trenches for a length of about 100 feet along the strike of the deposit. Elsewhere, assay values were generally low. In August of the same year a sample from the richer section of the deposit was submitted to the Bureau of Mines, Department of Mines and Resources, Ottawa, for an ore dressing test. The sample assayed 1·045 ounces of gold and 0·10 ounce of silver a ton, was found to be easily cyanided, and that from 60 to 70 per cent of the gold was recoverable by amalgamation.¹ Diamond drilling was started in the autumn of 1934. The vein was traced in four diamond drill holes beneath a swamp on the Rita No. 1 fraction, and the section in the vicinity of the shaft on the Rita No. 1 claim was tested in eleven holes, which intersected the vein at vertical depths of 50 to 150 feet. Assays were low except in one drill hole, which cut high-grade material at a depth of about 60 feet at a point 75 feet northeast of the shaft. From the results of the surface work and diamond drilling, it was estimated that 2,850 tons of ore with a grade of 0·74 ounce of gold a ton and an average width of 7·3 feet were contained in a shallow ore-body extending on the surface for 30 feet southwest and 90 feet northeast of the shaft.

In 1936, three additional holes were put down beneath the small ore-body to intersect the vein at 150 to 200 feet beneath the surface. At that time further drilling was also undertaken to test a theory that ore would be found where the vein might be expected to cross in depth a dyke of diabase that outcrops 350 feet west of the vein and strikes about parallel to it. Preliminary drilling indicated that the dip of the dyke, for 150 feet from the surface, varies from 80 to 85 degrees southeast, and that the shear might, accordingly, be expected to cross the dyke at a depth of 800 to 1,000 feet. A long hole was then started at a point a few feet east of the dyke and with a dip of 83 degrees toward the shaft.

¹ Investigations in Ore Dressing and Metallurgy, July to December 1934; Mines Branch, Dept. of Mines, Canada, pp. 50-52.

It was hoped that the hole would enter the dyke and remain in it until the vein was reached. However, the hole curved so that the average dip was 79 degrees toward the vein and the hole did not enter the dyke, although it intersected the vein at a vertical depth of 680 feet. Operations were then abandoned.

The deposit consists of lenses and stringers of quartz deposited here and there along a shear and fracture zone. The zone lies in rhyolite lava for most of its length and crosses a dyke of porphyritic andesite; movement along the zone has offset the dyke about 50 feet. As shown in the prospect pits, the shearing and fracturing pinches out at a few places along the strike only to appear again a few feet to one side or the other. One such offset at a point about 90 feet northeast of the shaft is probably due to a cross fault. The deposit varies from a foot or two to 20 feet wide and is commonly 4 or 5 feet wide. In some pits shearing is pronounced and the country rock of rhyolite is altered to sericite schist across widths of 3 to 6 feet. More commonly shearing is confined to a zone a foot or less wide on one wall, and the remainder of the width of the zone is of irregularly fractured rhyolite. The schist is generally penetrated by a few lenses and stringers of quartz up to 1 foot wide and the cracks in the fractured rhyolite are filled with narrow veinlets and films of quartz or pyrite. Pyrite grains are disseminated through much of the rhyolite and through some of the quartz. The high-grade section of the deposit in the vicinity of the shaft comprises quartz lying in fractures in rhyolite and porphyritic andesite and in a shear zone in the dyke rock. Quartz and pyrite are more plentiful than at most other localities along the vein, and a small amount of brown-weathering carbonate occurs in the quartz. Gold is said to have been seen in much of the quartz in the shaft. The high-grade section of the vein lies partly in the dyke, but chiefly in rhyolite close to the foot-wall of the dyke. This suggests that the dyke may have had an influence in precipitation of the gold by damming the ascending solutions. At the southwest end, the Independence vein dies out in rhyolite near the boundary of the Rita No. 1 claim. To the northeast the vein continues beyond the property of Rice Lake Gold Mines, Limited, on ground held by the Angora Star Mining Syndicate, as described elsewhere.

No. 2 Zone (locality 38, Map 460A), locally known as the Golden Rod vein, lies on the Golden Rod claim and consists of a shear zone penetrated by lenses and stringers of quartz. It strikes about north 35 degrees west across a hill of rhyolite and dips from 50 to 60 degrees northeast. It has been traced in twenty-three prospect pits for a length of 1,100 feet and, in 1934, was tested to vertical depths of 80 to 180 feet in six diamond drill holes. In the pits and drill holes the zone varies from 5 to 15 or 20 feet wide and averages about 10 feet wide. Assays in gold are reported to be low.

For 450 feet from the southeast end of the deposit no vein quartz was seen in the schist zone. Elsewhere the sheared rock is penetrated by a few stringers and lenses of quartz rarely as much as 1 or 1½ feet wide. In one pit about midway along the deposit, vein quartz is much more plentiful than usual, but even there constitutes only about one-

third of the material. Some of the lenses and stringers of quartz along the shear carry pyrite, buff-weathering carbonate, and patches of fine-grained chlorite. In some of the pits, pyrite grains are disseminated through the schist.

No. 3 Zone (locality 37, Map 460A) is a short shear zone on the Golden Rod claim. It has been explored in three prospect pits and one diamond drill hole. The shear zone varies from 2 to 4 feet wide and holds a few small lenses and stringers of quartz carrying scattered patches of buff-weathering carbonate.

Two short veins of quartz lie near the shear zone, one just northeast and the other southeast (See Map 460A). These veins cut schistose rhyolite at an angle to the regional southeasterly striking cleavage and do not follow shear zones. The veins are up to $2\frac{1}{2}$ feet wide and carry carbonate, chlorite, and pyrite.

No. 4 Zone (locality 39, Map 460A) crosses the boundary line between the Golden Rod and Golden Rod No. 1 claims. The deposit consists of lenses and stringers of quartz in a shear zone striking north 25 degrees west and dipping about 65 degrees northeast. The zone is exposed in eight prospect pits and on natural outcrops for most of its length of 650 feet. In one pit, 20 feet deep, quartz lenses up to $1\frac{1}{2}$ feet wide and a few small quartz veins are distributed across 3 feet of schist. The quartz carries disseminated grains of pyrite and is cut by stringers of buff-weathering carbonate. Elsewhere along the zone quartz is less plentiful or is lacking.

No. 5 Zone (locality 40, Map 460A) is a long shear zone extending for 4,300 feet along an average strike of north 45 degrees west from the southwest part of the Ranger claim through the Golden Rod, Ruby fraction, and Ruby claims to the southeast part of the San Antonio Extension claim, where it passes beneath drift and may continue much farther northwesterly. The shear displaces a dyke of diabase 1,500 feet, but does not offset porphyry dykes more than about 100 feet. As both types of dykes appear to be dipping close to vertical this indicates that there were two periods of movement along the zone, one after the invasion of the diabase, but before the porphyry dykes had been injected, and another following the intrusion of the porphyry.

The zone follows a drift-filled depression for part of its length and at other places is well exposed on natural outcrops. It has also been exposed in some eighteen prospect pits distributed at irregular intervals along the strike. Most of the work has been done along 900 feet of the zone where it crosses the Golden Rod claim. Several pits have also been dug at close intervals at a locality where the shear crosses a porphyry dyke in the southeast part of the San Antonio Extension claim. At the latter locality the schist zone dips 60 degrees northeast, is about 15 feet wide, and carries lenses of quartz up to 3 feet wide here and there across the full width. Quartz is fairly plentiful in some other pits also, but elsewhere along the shear zone occurs as only a few small stringers or lenses or is lacking. The vein quartz carries patches and shreds of fine-grained, massive chlorite. No sulphide mineral was seen in any of the quartz or schist, but sulphides may occur in small amounts.

No. 6 Zone (locality 41, Map 460A) is an irregular zone of shearing along and near the northeast edge of a dyke of diabase on the Ruby fraction. The zone is well exposed on natural outcrops and in a few prospect pits for a distance of about 1,000 feet along the strike of north 10 degrees west. The schist along the zone dips from 65 to 70 degrees easterly. The shear zone varies from 10 feet to about 50 feet wide, and consists for the most part of highly crenulated schist. Later movement along the zone has produced numerous long fractures from one-half to one inch apart and lying parallel to the general strike of the zone. Only a few stringers and lenses of quartz up to 3 inches wide are present here and there in the shear zone. The quartz carries buff-weathering carbonate and a little chalcopyrite.

No. 7 Zone (locality 42, Map 460A) is a shear zone in porphyritic andesite on the Ruby fraction. The zone has been traced in three pits and on natural outcrops for a length of 150 feet along the strike of north 25 degrees west. In the pits the schist dips about vertically and is 8 to 10 feet wide. The schist is penetrated by lenses of quartz from 1 inch to 2 feet wide. The quartz holds much brown-weathering carbonate, patches of finely crystalline, massive chlorite, and shreds of sericite.

No. 8 Zone (locality 43, Map 460A) is a strong shear zone exposed here and there for 850 feet across the southwest part of the Ruby fraction. The schist zone has been tested in three prospect pits. It is commonly 20 feet wide. In places the schist across this width is penetrated by a few small stringers and lenses of quartz and a few lenses of reddish quartz porphyry.

No. 9 Zone (locality 44, Map 460A) extends about north 45 degrees west for about 1,800 feet across the north part of the Ruby claim and into the San Antonio Extension claim. For much of this distance the zone is poorly exposed along the walls of a depression or passes beneath broad areas of drift. About one-half dozen prospect pits have been sunk along the schist zone. Most of these show schist with little or no vein quartz. In one pit on the San Antonio Extension claim the schist holds a quartz lens 10 feet long and up to 2 feet wide. The quartz holds shreds and patches of chlorite and scattered patches of carbonate and red feldspar.

No. 10 Zone (locality 29, Map 460A) lies in the southwest part of the Thelma claim and is locally known as the Thelma vein. It has been traced in fifteen prospect pits for a length of 600 feet. The zone strikes north 15 degrees west. The shear is only a foot or two wide for 150 feet from the northeast end close to the west boundary of the claim and holds no vein quartz in this distance. Elsewhere the shear zone averages 3 or 4 feet wide and holds stringers and lenses of quartz up to 2 feet wide, but generally less than 6 inches wide. In all of the pits quartz is much less plentiful than schist. The quartz generally carries disseminated grains of pyrite and, in places, is very well mineralized with this mineral.

At the southeast end the shear zone narrows to one foot and apparently pinches out. The zone also pinches out to the northwest at the west boundary of the Thelma claim, but appears again a short distance along the strike and continues for 2,900 feet on the property of Ranger Gold Mines, Limited.

No. 11 Zone (locality 28, Map 460A) lies near the northeast boundary of the Rita No. 3 claim, and is exposed on natural outcrops and in three prospect pits for a length of 200 feet. The shear zone strikes north 30 degrees west and dips steeply northeast. A quartz vein from 1 to 2 feet wide and smaller quartz lenses have been introduced along the shear. The vein has a banded appearance due to parallel inclusions of schist.

No. 12 Zone (locality 23, Maps 460A and 461A) has been traced for 950 feet on the Rita No. 3 fraction and extends for an additional 350 feet on the Angora No. 6 claim. It strikes north 35 degrees west and dips about vertically. A dyke of hornblende lamprophyre and a dyke of coarse feldspar porphyry have been displaced by movement along the shear. Near the southeast end of the shear a dyke of fine-grained porphyry cuts the shear.

Schist along the zone varies at different localities along the strike from 3 feet to 8 feet wide. In places, a few stringers and lenses of quartz up to a foot wide have been introduced along the schist zone. At the locality where the shear is crossed by the fine-grained porphyry dyke, the dyke rock, although unsheared, is also penetrated by vein quartz. This suggests that, although the shearing occurred before the intrusion of the dyke, at least part of the vein quartz was introduced later than the dyke. The deposit has been explored in thirteen prospect pits.

OTHER DEPOSITS

Several other shear zones occur on the Thelma, Rita 3, Golden Rod, Ruby fraction, and other claims, as shown on Map 460A. Some trenching has been done on most of these zones, which have been traced from 150 feet to 650 feet along the strike. The schist in most of these zones holds, in places, a few lenses and stringers of quartz carrying carbonate and, rarely, small amounts of pyrite and chalcopyrite.

ANGORA STAR MINING SYNDICATE

This syndicate, with an office at 200 Bay Street, Toronto, Ontario, owns a block of some twenty-four claims lying north and east of the ground held by Rice Lake Gold Mines, Limited.

On one of these claims, namely, the Strike No. 1, the northerly extension of the No. 1 zone or Independence vein, which lies on the property of Rice Lake Gold Mines, Limited, as already described, has been traced in some half dozen prospect pits for a length of 600 feet (*See Map 463A*).

Rock near the zone is chiefly rhyolitic breccia holding fragments of basic lava. A narrow dyke of diabase follows the zone for about 400 feet and then swings northerly. The dyke rock along the zone is sheared only in places, although the rhyolite has been altered to schist. No vein quartz was noted in the sheared rhyolite or diabase. At one locality near the dyke, irregular cracks in rhyolite are filled with stringers of quartz. At the northeast end the dyke and shear zone are cut off by an easterly striking cross fault. At a locality 100 feet farther northeast, an easterly striking shear zone continues across the Strike No. 1 and the adjoining Rita claim, but no vein quartz or sulphides were noted along it.

RANGER GOLD MINES, LIMITED

PROPERTY AND DEVELOPMENT

Ranger Gold Mines, Limited, with an office at 941 Somerset Block, Winnipeg, Manitoba, was incorporated on July 19, 1934. The company holds a block of sixteen claims east of Rice Lake and south of Independence Lake. Seven of these claims were acquired from Consolidated Goldfields of Manitoba, Limited, three from Manitoba Mining and Exploration Company, Limited, and six from private owners. Seven of the claims lie south of the map-area. Those lying wholly or partly within the area include the Rex No. 1, Rex, Thistle, Thistle fraction, Odelias, Ranger, Ranger No. 2, Ranger No. 3, Ranger No. 1 fraction, and Buckle fraction.

About 1914 some trenching was done on the property and a prospect shaft was sunk on one of the veins, known as No. 1 zone. In 1934 surface work was continued by Ranger Gold Mines, Limited, and this company also completed 1,040 feet of diamond drilling in seven holes. No work was done on the claims during the summer of 1936.

GEOLOGY

Rocks on the property include, chiefly, rhyolite, trachyte, and porphyritic andesite breccia. These rocks vary from massive to schistose and the cleavage of the schistose varieties trends southeast. The lavas and breccia are cut by southeasterly trending dykes of porphyritic andesite, by a younger, northeast striking dyke of diabase, and by several still younger dykes of feldspar porphyry and quartz feldspar porphyry that also generally trend northeasterly.

VEINS

Several shear zones have been discovered on the property. One zone strikes north and dips 80 degrees west. The others strike from north 40 degrees west to north 5 degrees west and dip from 30 degrees northeast to vertical. One zone is apparently crossed by the dyke of diabase and probably formed prior to the intrusion of this rock. Another zone is followed for a short distance along its strike by a porphyry dyke, as if developed before the intrusion of this dyke, but the same shear zone offsets two other porphyry dykes and the diabase dyke. With these exceptions, the shear zones are younger than the dykes that they cross and have offset the dykes either to the right or to the left. The zones vary from 6 inches or less to 20 feet wide and from 200 feet or less to 3,000 feet long.

Vein quartz occurs in most of the shears, but is commonly sporadically distributed, and some of the zones are without vein material for considerable distances along their strike. The quartz occurs as veins, stringers, and lenses, the largest lens noted being 50 feet long and up to 15 feet wide. The quartz generally carries carbonate and chlorite, in places holds small amounts of red feldspar and sericite, and is commonly only slightly mineralized with pyrite, either as disseminated grains or

as streaks lying parallel to the vein walls. Chalcopyrite is rare. At one locality the wall-rock is much altered to rusty weathering carbonate and at another place carries grains of pyrite. One zone is invaded by lenses of rhyolite carrying scattered grains of pyrite. Some encouraging assays in gold are said to have been obtained along a short section of No. 1 zone, but assays elsewhere are reported to be low.

No. 1 Zone (locality 32, Map 460A) lies on the Ranger claim. It follows a curved course trending, on the average, about north 30 degrees west for a distance of 1,200 feet, across the greater part of the Ranger claim. To the northwest the zone continues for 250 feet into the Golden Rod claim and apparently dies out, although lying along the same general zone of shearing as No. 2 zone on this claim, as described elsewhere. To the southeast the shear also dies out, but is paralleled nearby by No. 2 shear zone which continues southeast to a point 100 feet beyond the boundary of the Ranger claim. As a result of movement along No. 1 shear zone a diabase dyke has been offset 350 feet, whereas the quartz-feldspar porphyry dykes have been offset for much shorter distances. As both kinds of dyke appear to dip about vertically, this suggests that there has been at least two periods of movement, one after the diabase dyke was intruded but before the porphyry dykes were injected, and another after the porphyry dykes had solidified.

Workings along the zone consist of fifteen prospect pits, a shaft reported to be 60 feet deep,¹ and six diamond drill holes.

The shear zone, as exposed on natural outcrops and in prospect pits, dips from 70 degrees northeast to vertical, varies from 5 to 15 feet wide, and averages approximately 9 feet wide. In seven prospect pits, for 130 feet southeast of the shaft, stringers and lenses of vein quartz are fairly plentiful and, in places, are distributed across the full width of the shear zone, which averages about 10 feet wide at this locality. The stringers and lenses are from 1 inch to 1½ feet wide and carry irregular patches of fine-grained, massive chlorite, patches of carbonate, and rare specks of pyrite. It is reported that the deposit for a length of 90 feet southeast of the shaft gave an average assay value of 0·4 ounce of gold across 3·5 feet. The six drill holes cut the deposit at shallow depths and at intervals of 50 feet or less along the strike for 150 feet southeast and 70 feet northwest of the shaft. The cores are reported to have shown low assays in gold and to have cut smaller amounts of vein quartz than are exposed at the surface.

Elsewhere along the shear zone, quartz is generally lacking or is present in inconspicuous amounts. Near the southeast end of the zone, however, quartz lenses up to 3 feet wide are exposed for 25 feet along the strike. Near the northwest boundary of the claim the schist along the zone is much altered to rusty weathering carbonate.

No. 2 Zone (locality 31, Map 460A) lies along the same general zone of shearing as No. 1 zone, but does not connect with it. It parallels No. 1 zone for a short distance and extends south 15 degrees east for 550 feet to the edge of a muskeg just beyond the southeast boundary of the

¹ Bramble, C. A.: Rice Lake Gold Area; Manitoba's Northland, 1918, p. 34.

Ranger claim. Schist along the zone is crenulated, dips about 75 degrees easterly, is about 10 feet wide, and holds scattered lenses of quartz up to 6 feet wide and 40 feet long. The quartz carries chlorite and buff-weathering carbonate.

No. 3 Zone (locality 34, Map 460A) lies on the Ranger claim where it has been traced on natural outcrops and in seven prospect pits for a length of about 900 feet. It strikes about north 30 degrees west and dips about 80 degrees northeast. The zone crosses dark and light grey porphyritic rhyolite and is apparently cut by a dyke of diabase, as if the shearing were earlier than this dyke. Dykes of quartz porphyry and feldspar porphyry appear to end against the shear zone, as if the shearing were earlier than these dykes also. Schistose rhyolite along the zone is in most places about 10 feet wide, but at one locality is only about 1 foot wide. In most of the pits vein quartz is lacking, whereas in others the schist is penetrated by a few small lenses of quartz and veinlets of carbonate. The quartz carries red feldspar, buff carbonate, and, in places, abundant pyrite. Lenticular bodies of rhyolite, which have been injected into some parts of the schist zone, carry disseminated grains of pyrite.

To the southeast the zone passes beneath drift and appears again near the southeast boundary of the Ranger claim and on the adjacent part of the Republic claim, where it is 15 or 20 feet wide and holds only a few lenses of quartz.

No. 4 Zone (locality 33, Map 460A) apparently branches from the northeast side of No. 1 zone and continues north for 300 feet. The zone crosses rhyolite and a dyke of quartz-feldspar porphyry. The porphyry along the zone is cut by many small quartz stringers, commonly trending easterly. One quartz lens follows along the shear zone, varies from $2\frac{1}{2}$ to 5 feet wide for a length of 50 feet, dips 80 degrees west, and carries a little pyrite along parallel dark streaks in the quartz.

No. 5 Shear Zone (locality 30, Map 460A) lies on the Ranger No. 1 fraction. It has been traced for 400 feet along the strike of north 5 degrees west and probably continues northerly for an additional 350 feet. The zone varies from 1 to 5 feet wide, and dips vertically. Schist along the zone holds irregular veinlets of quartz and lenses of quartz up to $2\frac{1}{2}$ feet wide and 5 feet long. In the southern part of the shear zone a quartz vein is exposed for 100 feet along the strike and varies from $\frac{1}{2}$ foot to 2 feet wide. The quartz is white and carries patches of massive, fine-grained chlorite.

No. 6 Shear Zone (locality 35, Map 460A) is the northwesterly continuation of No. 10 zone, or Thelma vein, on the property of Rice Lake Gold Mines, Limited. No. 6 zone strikes north 40 degrees west and extends for 3,000 feet across the Thistle, Rex, and part of the Rex No. 1 claims. The zone of schist varies from 5 to 10 feet wide and dips from 60 to 80 degrees northeast.

At a locality where the zone crosses and offsets a diabase dyke and has been tested in two prospect pits, the zone carries numerous small stringers of carbonate and a few lenses of quartz mixed with much buff-weathering carbonate. The schist, in places, carries disseminated grains

of pyrite. Elsewhere along the shear zone vein quartz, as far as observed, is lacking.

No. 7 Zone (locality 27, Map 460A) lies in the west part of the Odelias claim. It crosses dark grey, porphyritic rhyolite and has been traced for 200 feet along the strike of north 15 degrees west in four prospect pits. Schistose rhyolite along the zone varies from 6 inches to 1 foot wide and dips about 30 degrees east. The schist, in places, holds lenses of quartz carrying disseminated grains of pyrite.

No. 8 Zone (locality 26, Map 460A) lies in the central part of the Odelias claim and is exposed at intervals in nine prospect pits and on natural outcrops for a length of 700 feet. The deposit strikes north 5 degrees west and dips from 45 to 60 degrees easterly. The shear zone varies from 3 to 15 feet wide. At the north end it is about 15 feet wide and carries, across this width and for a length of 100 feet, many veinlets and lenses of quartz. The lenses are up to 5 feet wide and 20 feet long, and hold carbonate, a little red feldspar, and some coarse pyrite. At a locality about midway along the deposit the schist holds a lens of quartz about 50 feet long and up to 15 feet thick. Pyrite and chalcopyrite are plentiful in the quartz, which also carries a small amount of carbonate and a few shreds of chlorite and sericite. Small quartz lenses and stringers occur in the schist near the large lens. Other lenses of quartz lie just west of this large lens and just beyond the main shear zone. Elsewhere a few lenses and stringers of quartz occur at intervals along the main schist zone. The deposit passes beneath drift at both ends.

OTHER DEPOSITS

Several other shear zones have been located on the company's property within the map-area, and are shown on Map 460A. These carry little or no vein quartz.

CONSOLIDATED GOLDFIELDS OF MANITOBA, LIMITED

This company was incorporated on June 19, 1933, and has an office at 941 Somerset Building, Winnipeg, Manitoba. Within the map-area the following claims are owned: Ritz 1, 2, 3, 4, 6, 7, 8; Fox (lot 356); Big Horn; King Pin; King Pin 1, 2; King Kole; King Kole 1, 2, 3; Fox (lot 1210); Goldstone; Roth 2 fraction; Roth 3 fraction; and Dot fraction. The company holds substantial interests in Ranger Gold Mines, Limited, Bissett Gold Mines, Limited, and Packsack Mines, Limited. In 1936, the company and Mr. M. Rothenberger optioned the Chicamon claim and several other claims in the vicinity of Gold Lake. Quartz veins have been discovered on the Chicamon and Fox (lot 356) claims.

The Chicamon Vein (locality 24, Maps 460A and 461A) lies on the west part of the Chicamon claim. It has been traced across an outcrop of porphyritic andesite for a length of 400 feet along the strike of north 30 degrees west and passes beneath muskeg at both ends. In the autumn of 1915 and in the following winter a shaft was sunk to a depth of 60 feet on an incline of 80 degrees to the southwest. High-grade ore is

reported to have been found about 20 feet from the surface, and 2 tons of this ore were treated in a small stamp-mill that was operating on the Goldfield claim. One hundred and sixty dollars in gold is said to have been recovered. During the following year or two the shaft was sunk to its present depth of 75 feet, drifting at this horizon was carried on for 73 feet northwest and 12 feet southeast of the shaft, and a crosscut was driven 32 feet northeast from a point on the drift 9 feet northwest of the shaft. No further work was done on the deposit until the summer of 1936 when Consolidated Goldfields of Manitoba, Limited, dewatered and sampled the underground workings.

The vein material has been deposited along a shear and fracture zone, which is well exposed northwest of the shaft in four prospect pits and on natural outcrops. At this locality the zone varies from 2 to 6 feet wide and is penetrated by a few lenses and stringers of quartz and bodies of rhyolitic material. Patches of carbonate lie in the quartz, and grains of pyrite are disseminated through the quartz and rhyolite. A small branch vein extends northwesterly from the main zone. Southeast of the shaft the fracture zone continues, but holds very little vein quartz. The shaft has apparently been sunk on a short lens lying about 20 feet south of the main zone, but not now exposed on the surface. In the drift near the shaft a few stringers of quartz fill irregular cracks in rhyolite. In the crosscut a mineralized zone was crossed at a point 12 feet from the drift, and is possibly the downward extension of the shear and fracture zone on the surface. A specimen collected from this zone consists of grey rhyolite holding disseminated grains of pyrite and crossed by veinlets of quartz and carbonate. Beyond the mineralized zone the crosscut passes into porphyritic andesite.

The Fox Vein (locality 25, Map 460A) follows a shear zone traced on outcrops and in three prospect pits for a length of 400 feet along the strike of north 15 degrees west. The zone crosses a contact between rhyolite and fragmental porphyritic andesite, and apparently displaces the contact about 150 feet. The northwest half of the zone is of schist from 1 to 5 feet wide, with little or no vein quartz. The southeast half carries lenses and stringers of quartz. One short quartz lens is 5 feet wide and fills the full width of the shear zone; another lens varies from 1 to 2 feet wide and is 20 feet long. In some places small quartz veins branch outwards from the main zone and extend into adjacent rocks for 5 feet or so. Much of the quartz in the deposit carries a little carbonate and pyrite. Some of the quartz is banded with dark streaks lying parallel to the walls of the vein; finely crystalline pyrite occurs along the streaks.

Mineralized Dyke. In the northwest part of the Fox claim (lot 356) a mineralized rhyolite dyke strikes north 5 degrees east for a length of 550 feet. It has been explored in six prospect pits across widths of 20 to 40 feet. The rhyolite varies from grey to red, is unsheared, and carries disseminated grains of pyrite. A few fractures in the dyke are filled with small stringers of quartz and films of pyrite. The quartz stringers carry patches of carbonate and disseminated grains of pyrite and chalcopyrite. Gold is said to have been panned from the deposit.

GENEVA GOLD MINES, LIMITED

This company was incorporated on May 28, 1934, with an office at 403 McIntyre Block, Winnipeg, Manitoba. Within the map-area the company holds the following claims: Republic, Gold Fly, Marigold, Golden Star No. 1, Geneva, Geneva 1, 2, 3, 4, and Geneva fractions 5, 6, and 7. Some surface work has been done on the Marigold group, which comprises the Gold Fly, Marigold, and Golden Star No. 1 claims.

This work includes several prospect pits, which have been dug along a dyke of quartz-feldspar porphyry that strikes north 85 degrees east across the middle of the Marigold claim. In the pits, the dyke is from 20 to 30 feet wide, is slightly sheared, and is penetrated by small lenses of vein quartz. Small grains of pyrite are disseminated through some of the quartz and porphyry. Surface work has also been done on two other deposits, which may be called No. 1 and No. 2 zones.

No. 1 Zone (locality 45, Maps 459A and 460A) is a strong shear zone striking about north 60 degrees west across the three claims of the Marigold group and presumably continuing easterly beneath a swamp on the Ruby fraction. Movement along the zone has apparently displaced a diabase dyke about 800 feet to the right. Porphyry dykes are offset by lesser amounts in the same direction, and one dyke follows the shear for a short distance and is itself sheared, suggesting two periods of movement along the fault. Much of the schist along the zone is minutely crenulated and the crenulated schist is crossed by long fractures from 1 to 2 inches apart and lying parallel to the general strike of the zone. This, likewise, suggests two periods of movement. Drag-folds in the crenulated schist are so disposed as to indicate that they formed by movement in a direction opposite to that of the offset of the dykes. Almost no vein quartz has been introduced along the shear zone.

No. 2 Zone (locality 46, Maps 459A and 460A) is a short shear zone lying along the south wall of a dyke of porphyritic andesite on the Marigold claim. A prospect pit has been sunk about 10 feet on the zone. In the pit, red, schistose rhyolite has a cleavage dipping 85 degrees north and is penetrated by lenses of quartz up to 2 feet wide and 20 feet or more long.

MANITOBA GOLD CREEK MINES, LIMITED

This company holds a group of claims in the vicinity of Gold Creek near the outlet of Rice Lake. A deposit on the company's property, and apparently on the Little Three claim, has been traced for 150 feet across an outcrop of feldspathic quartzite (locality 47, Map 458A). The deposit strikes north 60 degrees west and dips about 50 degrees northeast. It has been explored in prospect pits and shallow diamond drill holes. In one pit quartz lenses up to 2 feet wide are distributed across 15 feet of schistose quartzite. The quartz carries a little white feldspar and fine-grained chlorite, and the quartzite near the vein material is mineralized with a small amount of pyrite. The deposit is poorly exposed in other pits.

O.K. No. 9 CLAIM

Some stripping and test pitting has been done on a zone of irregular quartz stringers and veinlets (locality 48, Map 458A), which probably lies on the O.K. No. 9 claim. This claim is held by Leslie Cooney, 1005 Lindsay Building, Winnipeg, Manitoba. Rocks in the vicinity of the deposit are grey feldspathic quartzites with beds striking northwest and dipping steeply southwest. The vein zone strikes north 40 degrees east, nearly at right angles to the bedding of the quartzite. The vein material apparently extends about 250 feet along the strike, although much of this length is covered by drift. Where exposed, the deposit does not follow a marked shear zone, but consists of a network of intersecting stringers of quartz filling fractures in the quartzite. At one locality vein quartz is much more abundant than country rock across a width of 5 feet. Elsewhere the veinlets are more widely spaced and are distributed across a width of 10 feet. The quartz is white, carries small amounts of red feldspar, carbonate, and massive, fine-grained chlorite, and is cut by a few films of finely crystalline pyrite.

BRUCE CONSOLIDATED GOLD MINES, LIMITED

This company was incorporated on August 26, 1919, to develop a group of claims on which gold was discovered in 1918 by J. J. Papineau. The company holds six claims, including the Gold Plate, September Morn, and Canada claims, shown on Map 461A, and the Bruce, Bruce No. 2, and Bruce fraction just to the southeast.

In 1920 J. S. DeLury reported¹ that several small rich veins had been opened up by stripping, trenching, and test pitting. He says that some of the veins fill irregular fissures and others follow sheared zones, parts of which are well mineralized. A band of fractured granite on one of the Bruce claims is reported to carry a considerable amount of pyrite and interesting values in gold. Following DeLury's examination no further work is known to have been done on the deposits until 1934, when surface work was resumed. During the summer of 1936 some diamond drilling was done on deposits on the September Morn claim.

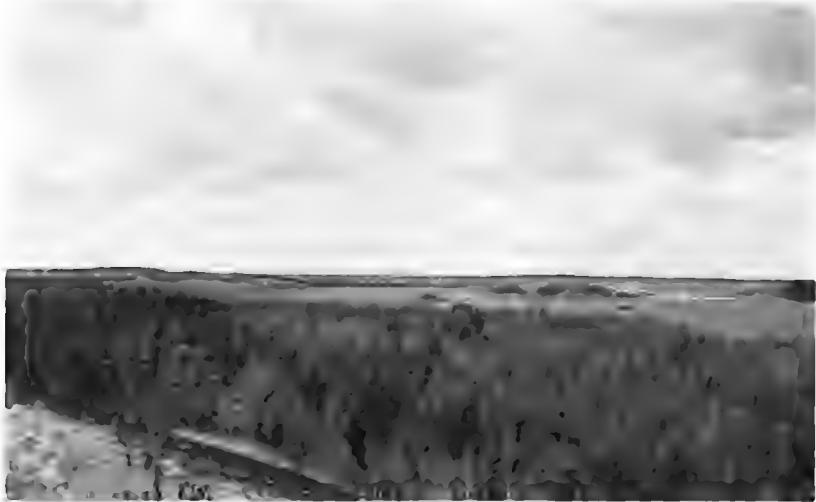
Several small deposits of quartz have been found on the September Morn claim, which may be reached over a trail leading from the southeast bay of Geld Lake. The deposits lie in a large body of pink and grey quartz diorite, which is generally massive, but in places has been slightly sheared and fractured along narrow zones. Lenses and stringers of quartz have been deposited along some of these disturbed zones, most of which strike northeasterly and dip either northwest or southeast. Two of these deposits, which may be called No. 1 zone and No. 2 zone, are described below.

No. 1 Zone (locality 21, Map 461A) strikes north 30 degrees east, dips 70 degrees northwest, and is exposed for 100 feet. It has been intersected in a shallow diamond drill hole. The deposit, in places, consists of small quartz stringers lying parallel to one another across a width of

¹ DeLury, J. S.: Mineral Prospects in Southeastern Manitoba; Manitoba Bulletin 1920, pp. 26-27.

5 feet of quartz diorite, but commonly consists of only a single quartz stringer from 1 inch to 3 inches wide, deposited along a slickensided slip plane in the granitic rock.

No. 2 Zone (locality 22, Map 461A) strikes north 40 degrees west and dips about 50 degrees southwest. This zone is apparently 250 feet long, but is exposed only in a large prospect pit at the southeast end and in a prospect shaft near the northwest end. To the southeast it apparently ends on approaching No. 1 zone, described above. It has been intersected in at least two shallow diamond drill holes. In the large pit, quartz lenses up to 6 inches wide are sparsely distributed across about 10 feet of fractured quartz diorite. Some gash veinlets consist of euhedral quartz crystals along their outer edges and buff-weathering carbonate in the middle. Patches and crenulated streaks of black tourmaline lie in the carbonate and a few crystals of pyrite are scattered through the carbonate, quartz, and nearby quartz diorite. Some of the quartz bodies hold patches of massive, finely crystalline chlorite.

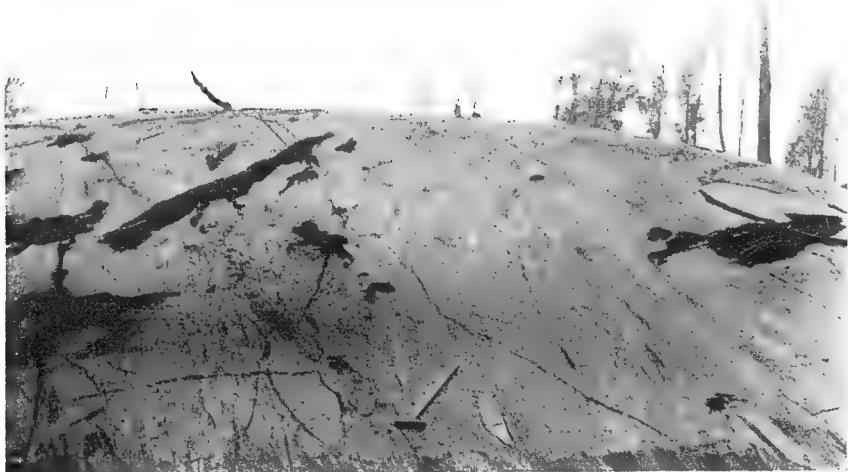


A. Rice Lake and San Antonio mine. Looking northwest.



B. Angular and subangular fragments of porphyritic andesite in trachyte breccia. Southeastern part of Gold Cup No. 2 fraction.

PLATE III



A. Tracyte breccia. Southeastern part of High Ridge No. 1 claim.



B. San Antonio mine. Mill and office left, No. 3 shaft centre, No. 2 shaft right.

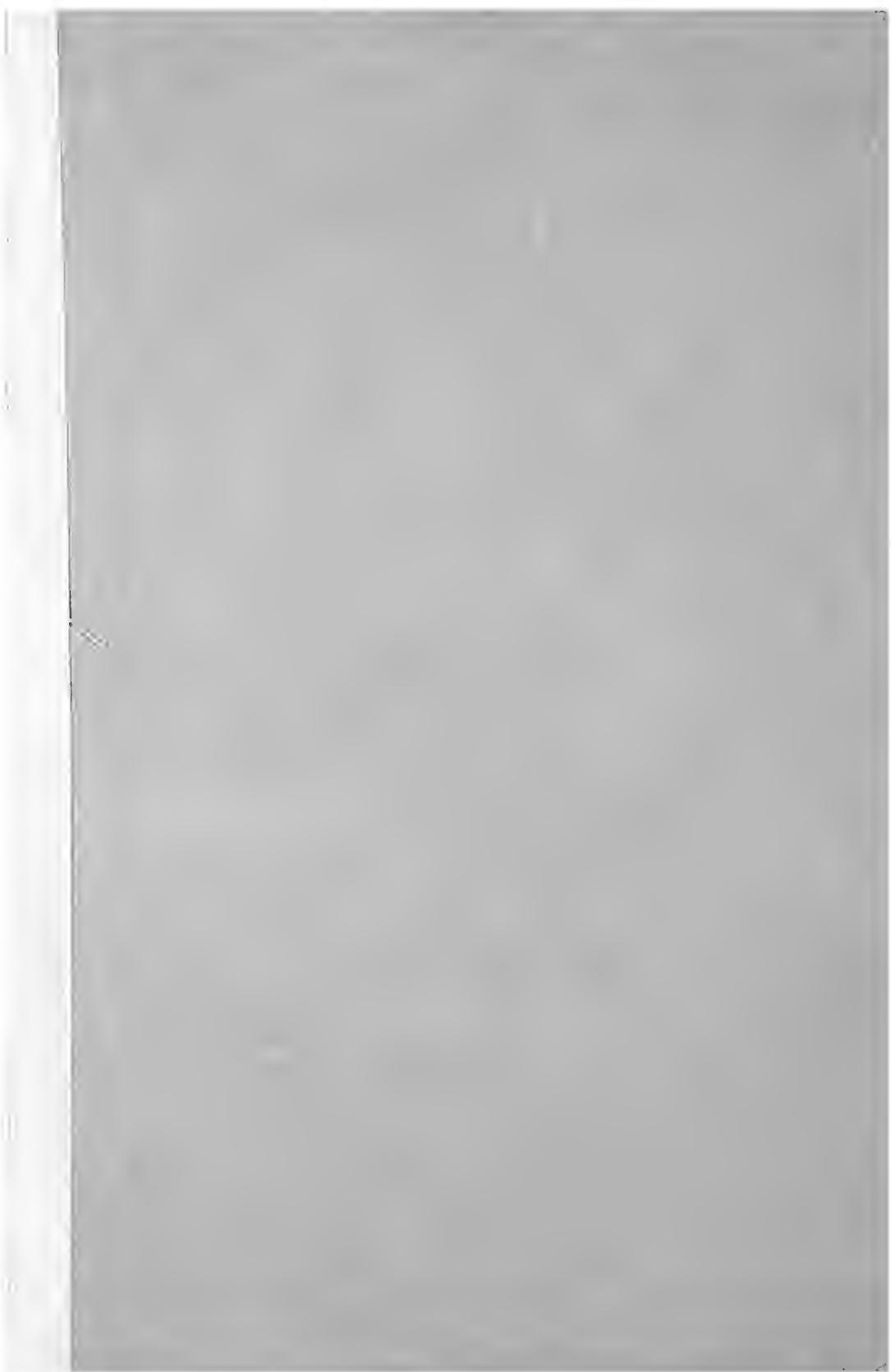
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1838

LEGEND

ARCHEAN
/EARLY PRECAMBRIAN

14	Quartz-feldspar porphyry, feldspar porphyry, rhyolite, andesite
13	Lamprophyre
12	Quartz diorite
11	"Quartz-eye granite"(porphyritic quartz diorite)
10	Meta-diabase
9	Meta-gabbro, quartz diorite
8	Porphyritic andesite
RICE LAKE SERIES	
5	Basalt
4	Tuff, arkose
3	Porphyritic basalt
2	Rhyolite, trachyte, andesite, breccia, iron formation
1	Porphyritic andesite breccia
Recent alluvium and glacial drift	
23	Quartz veins and shear zones (defined, approximate) (numbered as in index)

Geological boundary (defined, approximate)
 Dip of quartz vein and shear zone
 Bedding (inclined)
 Bedding (direction of dip known, upper side of bed unknown)
 Schistosity (inclined)
 Glacial striæ

 Buildings
 Road not well travelled
 Trail
 Power line
 Marsh and muskeg

*Base-map compiled by the Topographical Survey from
information supplied by the Manitoba Department of
Mines and Natural Resources.*

Geology by C. H. Stockwell, 1936.

INDEX TO QUARTZ VEINS AND SHEAR ZONES

- 23.** No.12 zone, Rice Lake Gold Mines, Limited
 - 24.** Chicamon vein
 - 25.** Fox vein, Consolidated Goldfields of Manitoba, Limited
 - 26.** No.8 zone, Ranger Gold Mines, Limited
 - 27.** No.7 zone, Ranger Gold Mines, Limited
 - 28.** No.11 zone, Rice Lake Gold Mines, Limited
 - 29.** No.10 zone, Rice Lake Gold Mines, Limited
 - 30.** No.5 zone, Ranger Gold Mines, Limited
 - 31.** No.2 zone, Ranger Gold Mines, Limited
 - 32.** No.1 zone, Ranger Gold Mines, Limited
 - 33.** No.4 zone, Ranger Gold Mines, Limited
 - 34.** No.3 zone, Ranger Gold Mines, Limited
 - 35.** No.6 zone, Ranger Gold Mines, Limited
 - 36.** No.1 zone, or Independence vein, Rice Lake Gold Mines, Limited
 - 37.** No.3 zone, Rice Lake Gold Mines, Limited
 - 38.** No.2 zone, or Golden Rod vein, Rice Lake Gold Mines, Limited
 - 39.** No.4 zone, Rice Lake Gold Mines, Limited
 - 40.** No.5 zone, Rice Lake Gold Mines, Limited
 - 41.** No.6 zone, Rice Lake Gold Mines, Limited
 - 42.** No.7 zone, Rice Lake Gold Mines, Limited
 - 43.** No.8 zone, Rice Lake Gold Mines, Limited
 - 44.** No.9 zone, Rice Lake Gold Mines, Limited
 - 45.** No.1 zone, Geneva Gold Mines, Limited
 - 46.** No.2 zone, Geneva Gold Mines, Limited

GEOLOGICAL SURVEY



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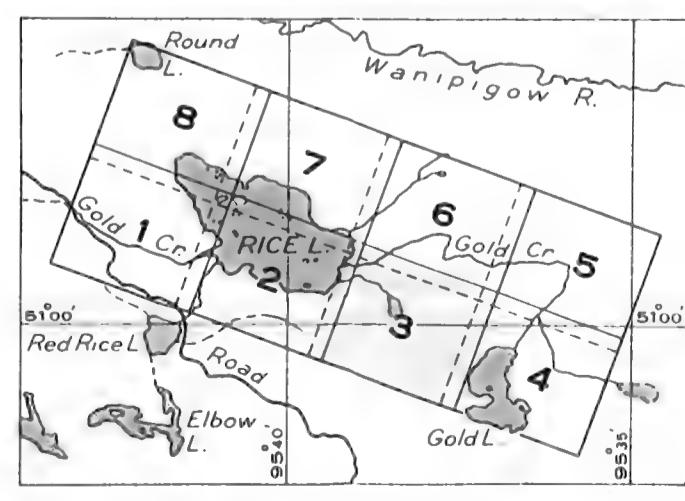
MAP 460 A

SHEET 3

RICE LAKE-GOLD LAKE AREA

(IN EIGHT SHEETS)

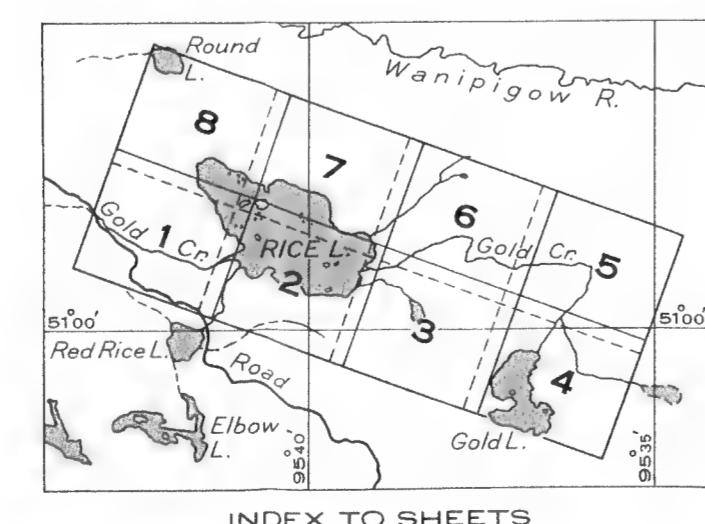
Scale, $\frac{1}{6000}$ or 1 Inch to 500 Feet



INDEX TO SHEETS

Approximate magnetic declination, 11°00' East.

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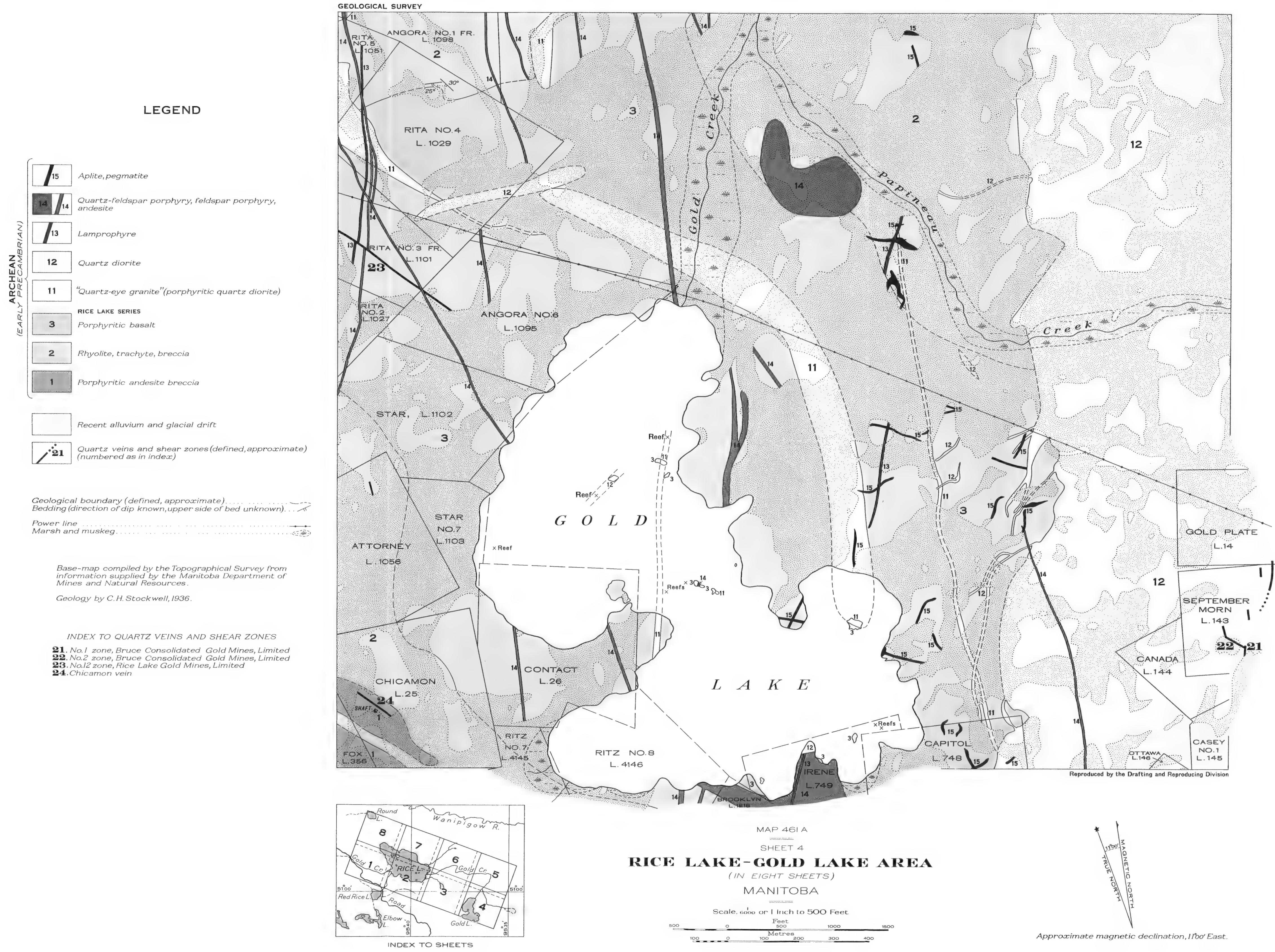
MAP 458 A
 SHEET I
RICE LAKE-GOLD LAKE AREA
 (IN EIGHT SHEETS)
 MANITOBA

Scale, 1:600 or 1 Inch to 500 Feet
 Feet 500 1000 1500
 Metres 100 200 300 400

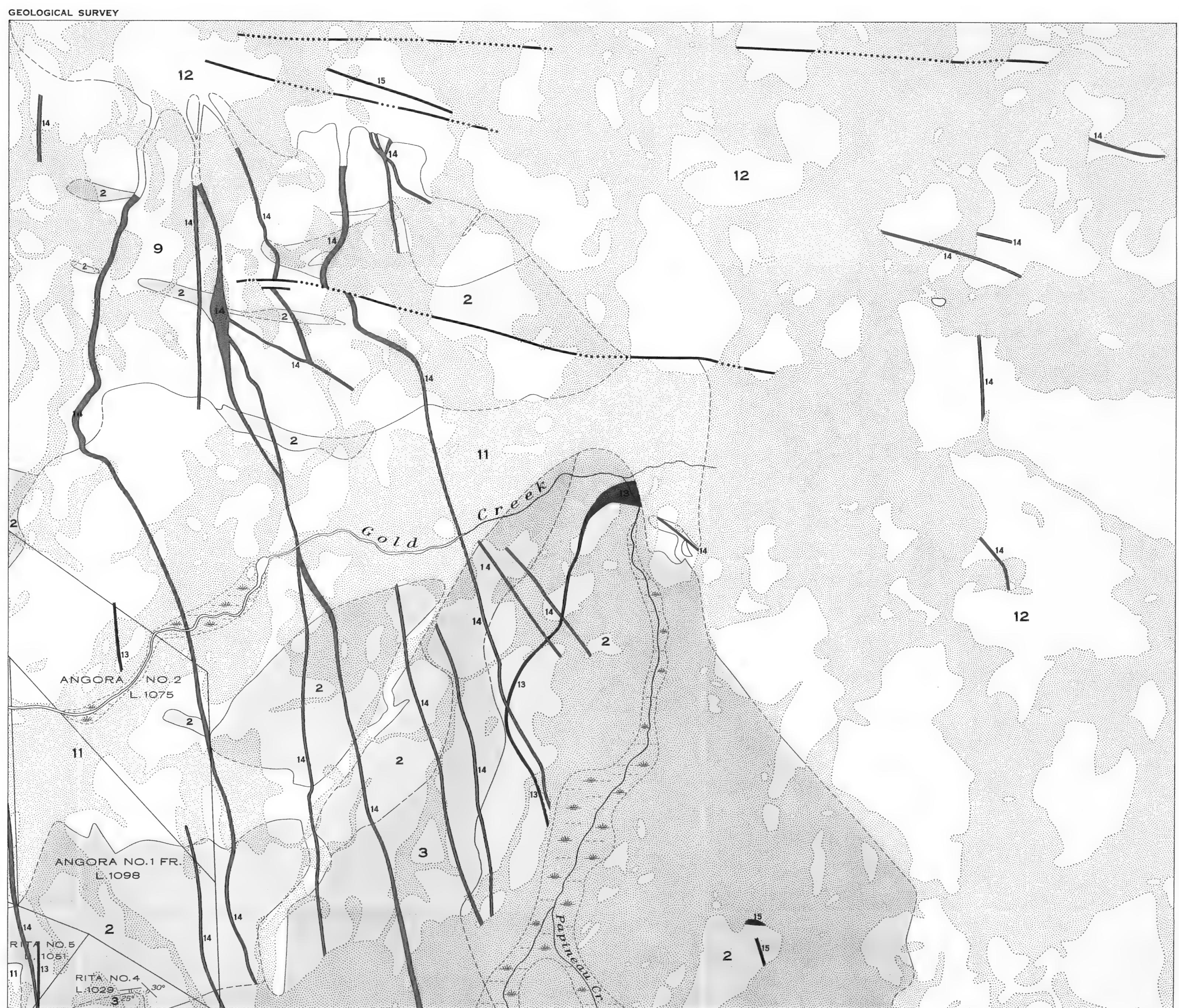
*
 TRUE NORTH
 10°30' MAGNETIC DECLINATION, 10°30' East.

$$\langle \mathbb{HE},\,\mathcal{H}^{\mathcal{O}}_{\omega}\rangle$$

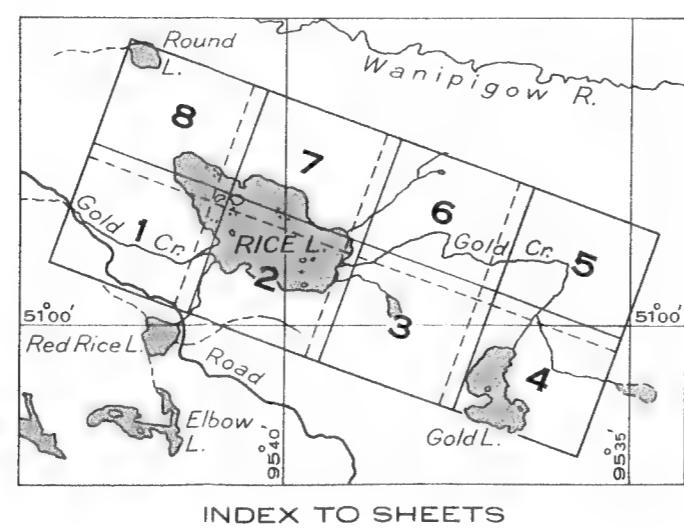
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INDEX TO SHEETS

MAP 462 A
 SHEET 5
RICE LAKE-GOLD LAKE AREA
 (IN EIGHT SHEETS)
 MANITOBA

Scale, $\frac{1}{600}$ or 1 Inch to 500 Feet
 Feet 500 1000 1500
 Metres 100 200 300 400

*
 11°30' TRUE NORTH
 MAGNETIC NORTH
 Approximate magnetic declination, 11°30' East.

$\mathcal{G}_s/\mathcal{G}$

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GEOLOGICAL SURVEY

LEGEND

ARCHEAN (EARLY PRECAMBRIAN)

- 14** Quartz-feldspar porphyry, feldspar porphyry, rhyolite, andesite
- 13** Lamprophyre
- 12** Quartz diorite
- 11** "Quartz-eye granite" (porphyritic quartz diorite)
- 10** Meta-diabase
- 9** Meta-gabbro, meta-diorite, quartz diorite
- 8** Porphyritic andesite
- RICE LAKE SERIES**
- 7** Trachyte breccia
- 6** Porphyritic andesite
- 5** Basalt
- 4** Tuff, arkose, conglomerate
- 3** Porphyritic basalt
- 2** Rhyolite, trachyte, andesite, breccia
- Recent alluvium and glacial drift
- 18** Quartz veins and shear zones (defined, approximate) (numbered as in index)

Geological boundary (defined, approximate).
 Dip of quartz vein and shear zone
 Bedding (vertical).
 Bedding (direction of dip known, upper side of bed unknown).
 Schistosity (inclined, vertical).

Buildings
 Road not well travelled
 Trail
 Power line
 Marsh and muskeg

Base-map compiled by the Topographical Survey from information supplied by the Manitoba Department of Mines and Natural Resources.

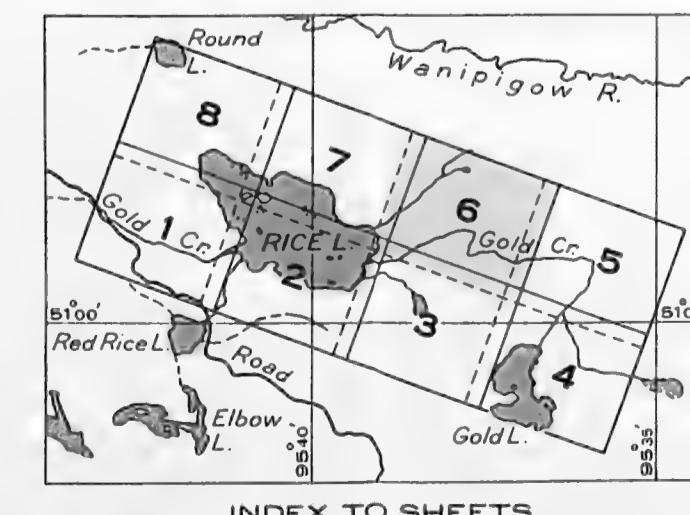
Geology by C.H. Stockwell, 1936.

INDEX TO QUARTZ VEINS AND SHEAR ZONES

- 18**. No.3 deposit, Normandy Gold Mines, Limited
- 19**. No.2 deposit, Normandy Gold Mines, Limited
- 20**. No.1 deposit, Normandy Gold Mines, Limited



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INDEX TO SHEETS

MAP 463 A
 SHEET 6
RICE LAKE-GOLD LAKE AREA
 (IN EIGHT SHEETS)
 MANITOBA

Scale, 1:600,000 or 1 Inch to 500 Feet
 Feet 0 200 400 600 800 1000 1200 1400
 Metres 0 100 200 300 400

* 15°
 TRUE NORTH
 MAGNETIC NORTH
 Approximate magnetic declination, 11°bo' East.

$\mathcal{D} \in \mathbb{C}^{n_1 \times n_2}$

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LEGEND

(EARLY PRECAMBRIAN)

14	Quartz-feldspar porphyry, rhyolite
10	Meta-diabase
9	Meta-gabbro, quartz diorite
8	Porphyritic andesite
RICE LAKE SERIES	
7	Trachyte breccia, porphyritic dacite breccia
6	Porphyritic andesite
5	Basalt
4	Tuff, arkose, conglomerate
2	Rhyolite, trachyte, breccia
	Recent alluvium and glacial drift
7	Quartz veins and shear zones (defined, approximate) (numbered as in index)

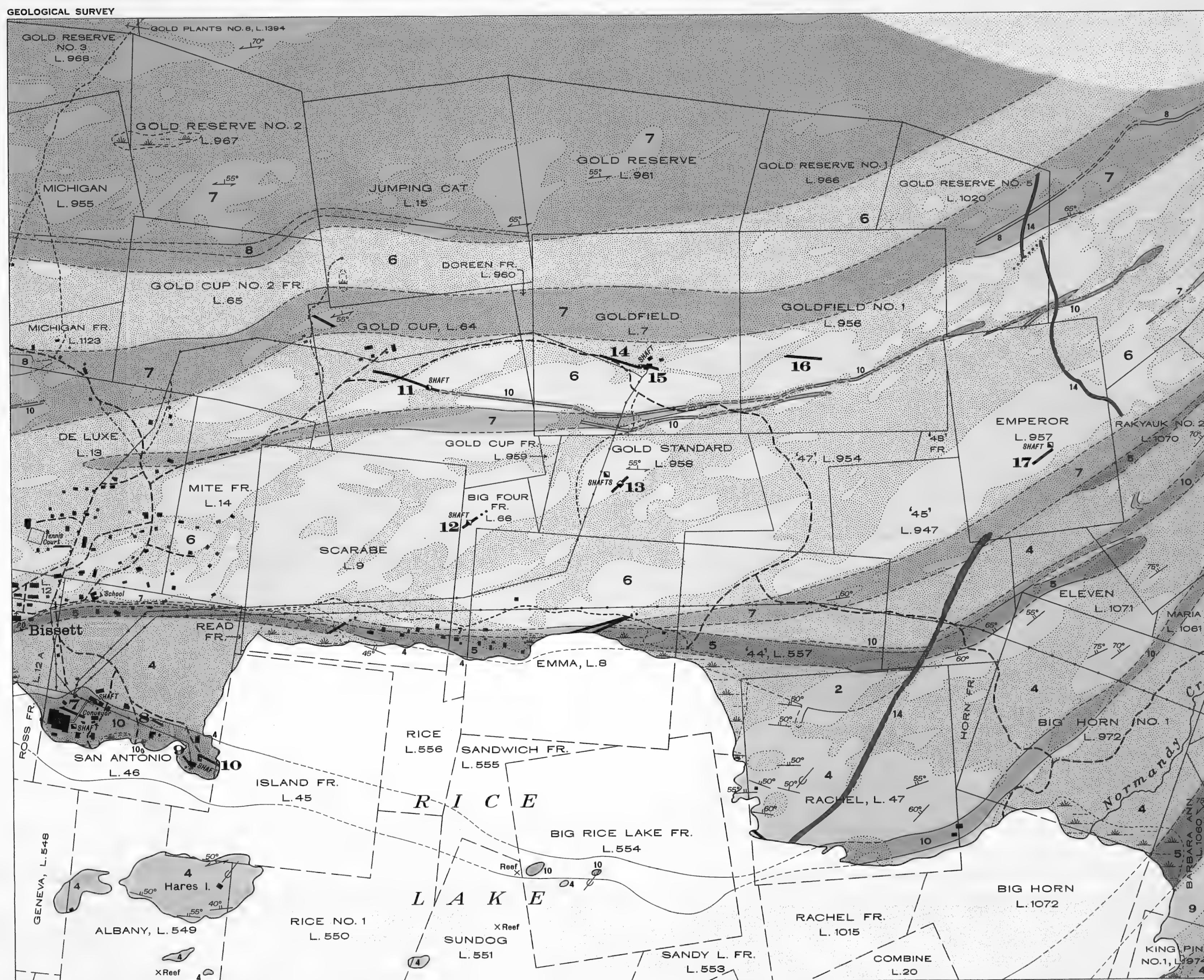
Geological boundary (defined, approximate).
 Bedding (inclined).
 Bedding (direction of dip known, upper side of bed unknown).
 Schistosity (inclined).
 Glacial striæ
 Buildings
 Road not well travelled.
 Trail
 Power line
 Power line along road
 Marsh and muskeg

Base-map compiled by the Topographical Survey from information supplied by the Manitoba Department of Mines and Natural Resources.

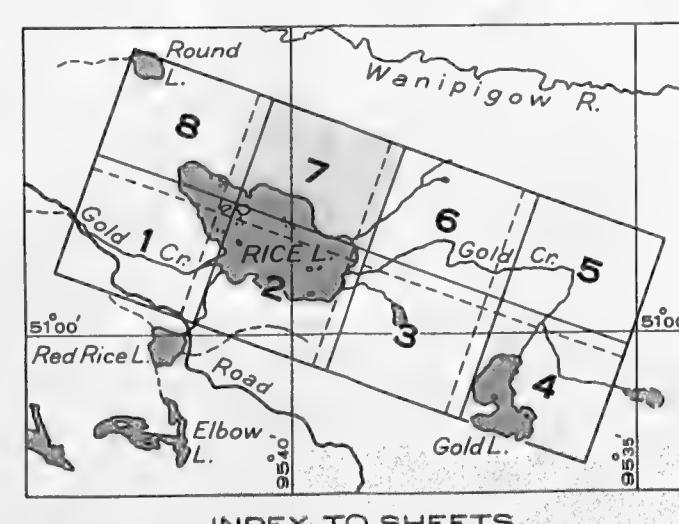
Geology by C. H. Stockwell, 1936.

INDEX TO QUARTZ VEINS AND SHEAR ZONES

7. No.3 vein, San Antonio Gold Mines, Limited
8. No.4 vein, San Antonio Gold Mines, Limited
9. No.2 vein, San Antonio Gold Mines, Limited
10. No.1 vein, San Antonio Gold Mines, Limited
11. No.4 vein, Wingold Mines, Limited
12. No.5 vein, Wingold Mines, Limited
13. No.6 vein, Wingold Mines, Limited
14. No.3 vein, Wingold Mines, Limited
15. No.1 vein, Wingold Mines, Limited
16. No.7 vein, Wingold Mines, Limited
17. No.8 vein, Wingold Mines, Limited



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INDEX TO SHEETS

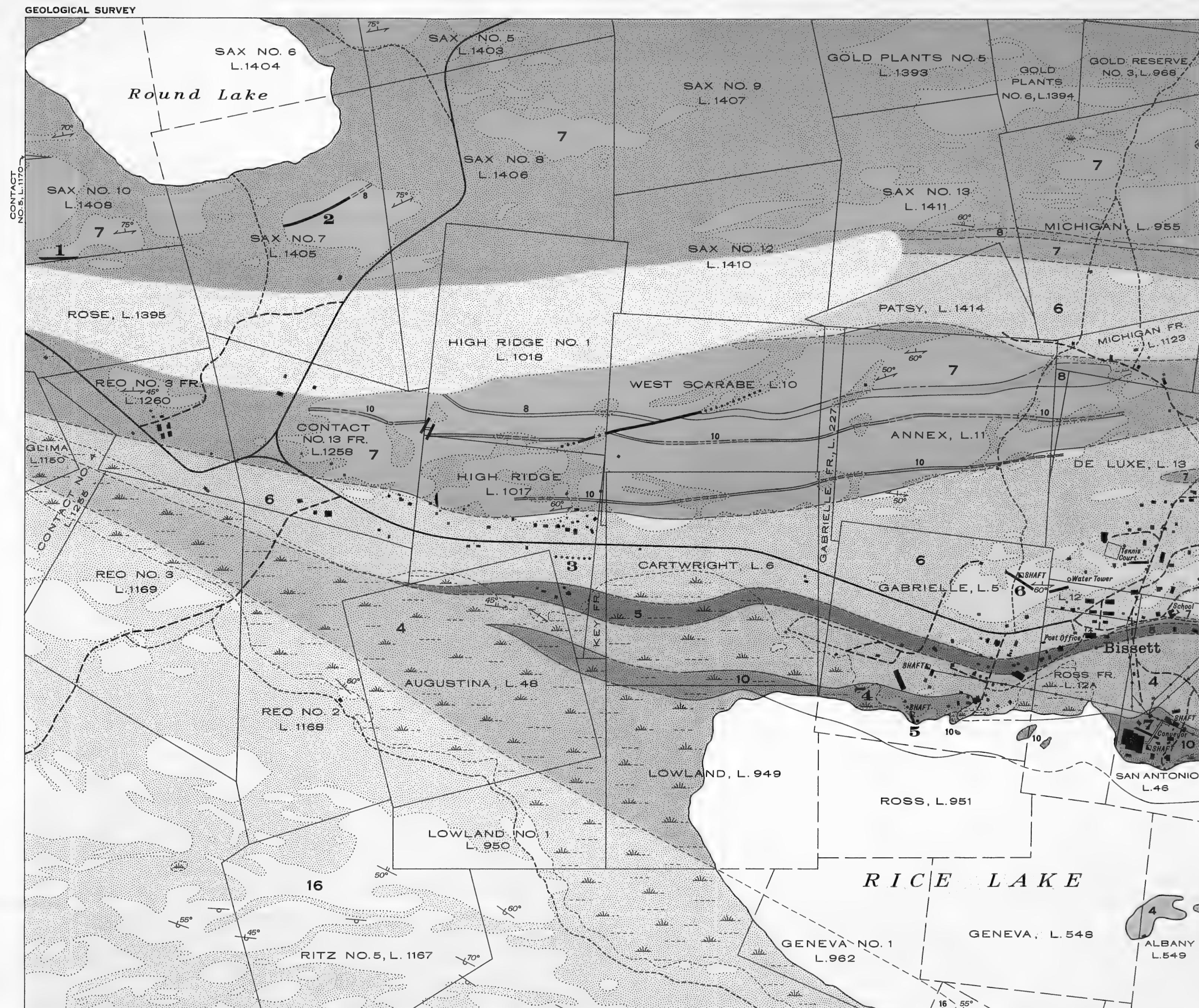
MAP 464 A
 SHEET 7
RICE LAKE-GOLD LAKE AREA
 (IN EIGHT SHEETS)
 MANITOBA

Scale, 1 mile or 1 Inch to 500 Feet
 Feet 0 500 1000 1500
 Metres 0 100 200 300 400

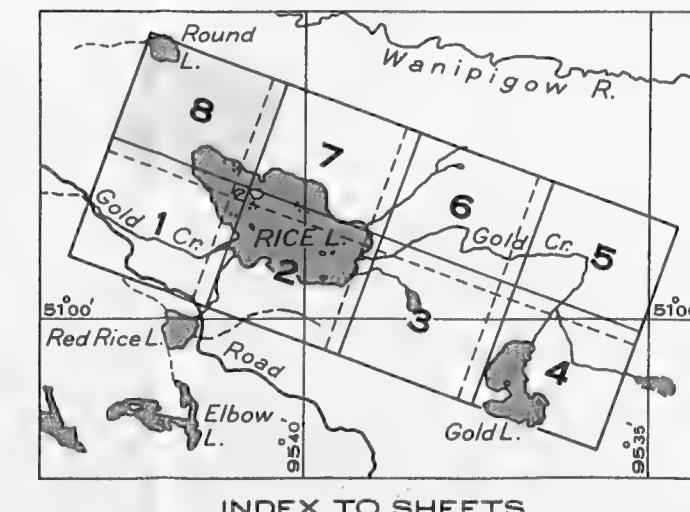
Approximate magnetic declination, 10°30' East.

* TRUE NORTH
 MAGNETIC NORTH

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MAP 465 A
 SHEET 8
RICE LAKE - GOLD LAKE AREA
 (IN EIGHT SHEETS)
 MANITOBA

Scale, 1:250,000 or 1 Inch to 500 Feet
 Feet
 Metres
 800 0 800 1000 1800
 100 0 100 200 300 400

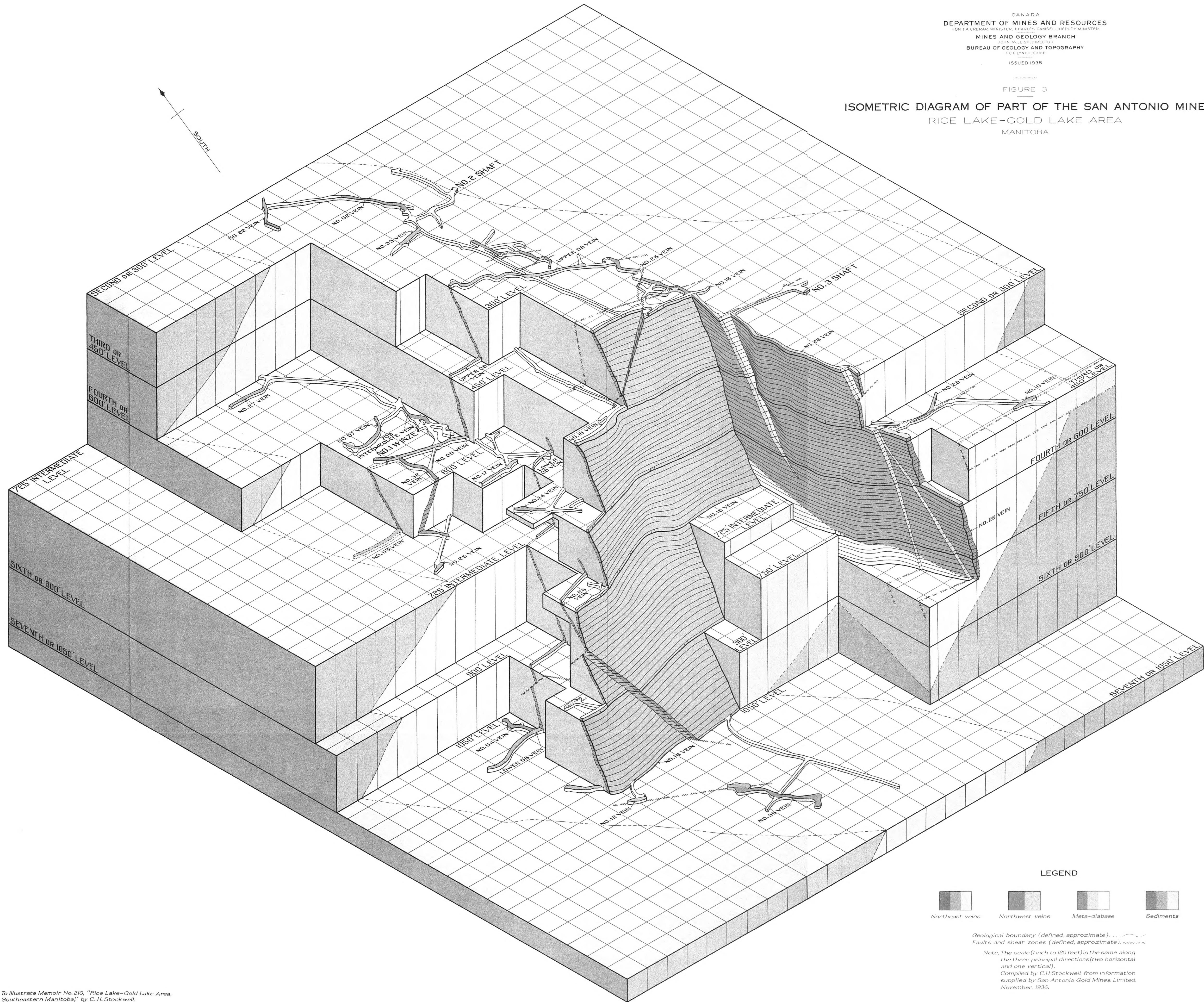
MAGNETIC NORTH
 Approximate magnetic declination, 10°30' East.

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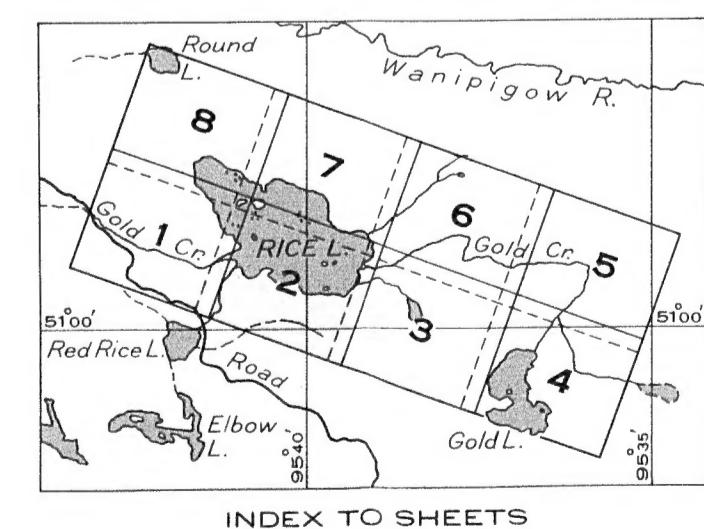
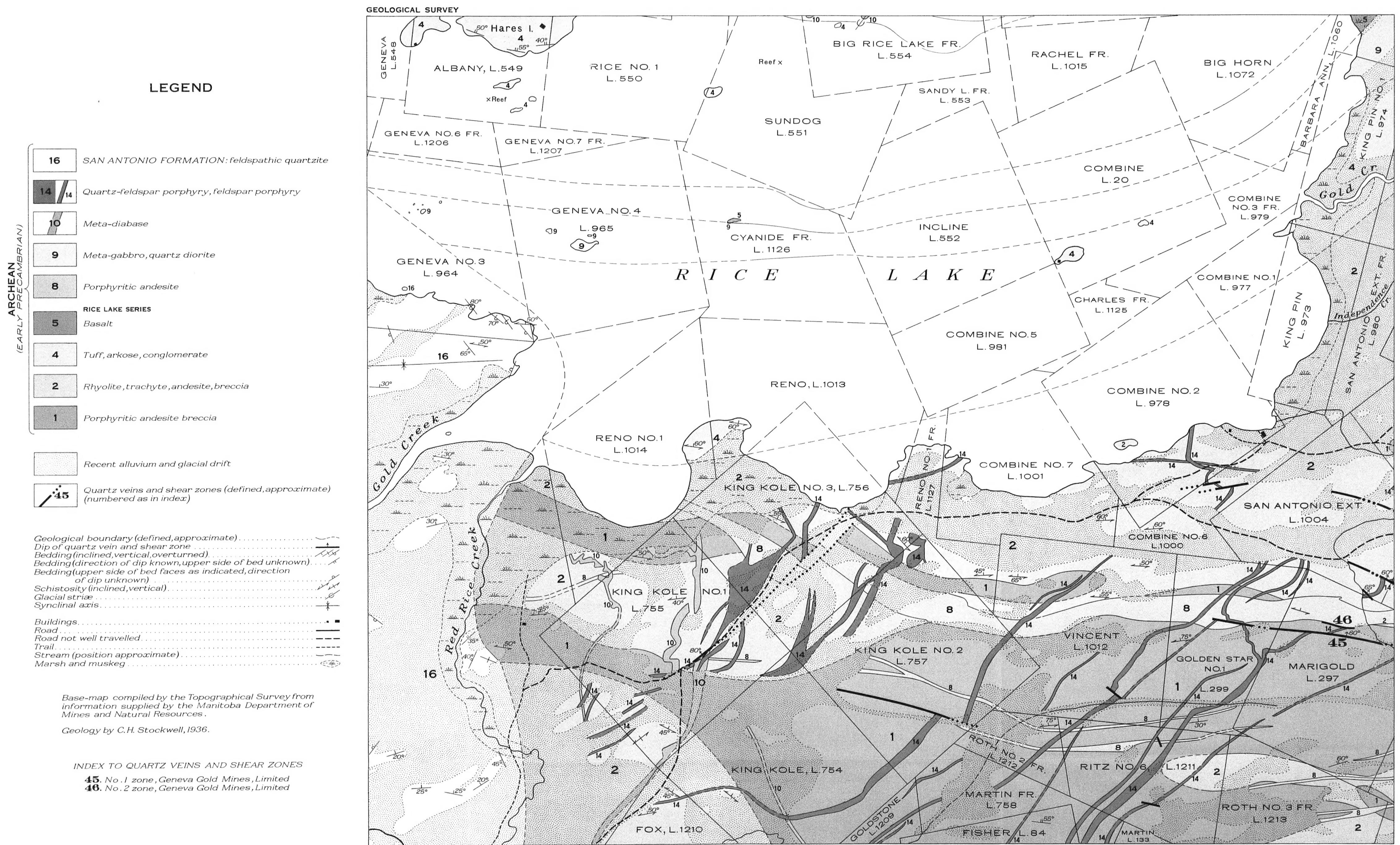
FIGURE 3

ISOMETRIC DIAGRAM OF PART OF THE SAN ANTONIO MINE
RICE LAKE-GOLD LAKE AREA
MANITOBA



To illustrate Memoir No. 210, "Rice Lake-Gold Lake Area Southeastern Manitoba," by C. H. Stockwell.

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MAP 459 A
SHEET 2
RICE LAKE-GOLD LAKE AREA
(IN EIGHT SHEETS)
MANITOBA

Scale, 1:6000 or 1 Inch to 500 Feet
500 0 500 1000 1500
Feet Metres
100 0 100 200 300 400

TRUE NORTH
MAGNETIC NORTH
14°00' Approximate magnetic declination, 14° East.

